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# Rock Grouting and Caisson Sinking for the Hales Bar Dam

Fissures and crevices in the rock foundation strata of the Tennessee River dam at Hales Bar, Tenn., a short distance below Chattanooga, compelled the builders of the dam to use very special methods. Cement-grout injection was tried on a remarkably large scale, with success in part of the foundation and failure in another part. To get through the worst-fissured strata and insure the cutting off of water flow under the dam, pneumatic caissons were sunk, in those sections where the grouting failed, and thus a tight artificial-rock foundation created. Incidentally the work proved so complicated that four successive contractors were engaged on it, the last being not a contractor at all but a firm of consulting engineers whose services were engaged to manage the construction. The first contractor started work eight years ago, and the job is only just completed.

FIG. 1. HALES BAR DAM WORK (LOOKING NE AT THE CLOSING SECTION, NOVEMBER, 1912)

(Floating plant massed in foreground; upstream cribs of Sec. 3 B coffer-dam under construction, and tops of east caissons of Sec. 4 at left; block sections of east part of overfall dam at right, with power house beyond.)

The Tennessee River westward from Chattanooga cuts through the Cumberland Mountains, and in this gorge it has steep gradient and contains many shoals and rapids. Channel improvement by the government has been done at various times in the past, but this was confined to dredging and removing some of the larger obstructions. The problem of improving the mountain section of the river for navigation remained contingent upon the construction of a dam which would pond the water over the most serious rapids. The great cost of such a dam prevented action until 1900 or shortly thereafter.

About the latter period various plans for navigation improvement were considered. Of several available locations for a dam, Scott's Point (see sketch map, Fig. 2) was regarded with most favor, and designs were made for a timber-crib dam with masonry lock. The idea that the navigation dam might also be made useful for generating hydraulic power was taken up shortly afterwards, and Chattanooga interests came out in support of a power project on this basis. The final result was that in 1904, Congress authorized the Secretary of War to grant permission to the city of Chattanooga to build a lock and dam at Scott's Point; and if within four months Chattanooga should fail to notify the Secretary of War of its intention to act on the permission, the Secretary might offer the franchise to C. E. James and J. C. Guild, of Chattanooga. The offer was made to James & Guild, they accepted the offer, and the Chattanooga & Tennessee River Power Co. was organized.

Shortly after, this company started engineering investigation of the project, through John Bogart and Thomas E. Murray. It was concluded that a location farther downstream would be preferable as producing a larger amount of power (it would also improve navigation over a longer stretch of river). Subsequently (1905) a new act of Congress authorized the company to locate the dam elsewhere than at Scott's Point, with approval of the Secretary of War. Under this authorization Hales Bar was finally selected as the site for the dam.

The franchise thus granted to the company under congressional authorization gives them the use of the power for 99 years and in turn requires them to pay the entire expense of building the dam and auxiliary work, under government approval and inspection throughout.

## HYDRAULIC AND PHYSICAL CONDITIONS

The Tennessee River is the most important tributary

of the Ohio and is said to have a slightly greater flow at its junction with the Ohio than the upper course of the Ohio itself. It is among the three or four largest rivers in the United States. At Chattanooga it has a drainage area of 21,418 square miles and a mean flow of 41,-

FIG. 2. SKETCH PLAN OF TENNESSEE RIVER FROM CHATTANOOGA TO HALES BAR

500 cu.ft. per sec., which represents a runoff of 55% of the rainfall of 47.6 in. annually. The minimum flow, from observations covering nearly a half century, is in the neighborhood of 6000 per sec., while the maximum flow is about the same as that of the Ohio, 500,000 cu.ft. per second.

A flood reaching 35 ft. on the Chattanooga gage means a river discharge of 220,000 cu.ft. per sec. During a period of 25 years this stage has been reached 17 times and has held for an average of three days a year. A 50-ft. stage is reached at long intervals and the maximum stage known is 60 ft. The large variation between low and high water complicates the problem of developing power. The available head on the turbines at Hales Bar ranges from nearly 40 ft. at low water (practically zero gage) to 20 ft. at 40-ft. gage, and still lower for higher floods.

The mountains in the Hales Bar neighborhood, which are ridges 800 to 1000 ft. above river level (and about 1400-1600 ft. above sea level), are made up largely of alternating layers of clay (shale), sandstone and coal, covered with a blanket of gravelly red clay (residual clay). A short distance above river level, however, Bangor limestone appears and the entire foundation of the dam is of this material. The Bangor limestone is honeycombed with crevices, channels and pockets (Fig. 3), the result of dissolving action of the water. Most of the channels and caves are filled with clay and gravel, but some carry clear water, found to be spring water from the mountain runoff.

At the time the designs for the dam were made and construction started, the extensive character of the fissuring and honeycombing probably was not known. The construction plan involved only simple methods such as might be applicable to sound rock, methods which failed when the honeycombing was run into. That the history of the work is so complex is largely due to difficulties with the honeycombed foundation rock.

### DESIGN OF THE DAM

The power company's engineers designed a solid overfall dam of cyclopean concrete, as shown in Fig. 4. Subsequently, when the foundation had to be carried down deeper than originally was in view, the section was [illegible] fied by increasing the base width 4 ft. 3 in. and al[illegible] the overfall face, resulting in the section also sho[illegible] Fig. 4. In method of design both of these dams [illegible] culated for foundation directly on solid rock. T[illegible] tual foundation on concrete caissons or piers is a[illegible] not to modify the nature or amount of the stre[illegible] the dam.

The orientation of the dam is practically east and [illegible] the river flowing south at this point. The lock is [illegible] west bank, in solid rock, and is 60 ft. wide by 31[illegible] long inside. Its lift is 20 to 40 ft., according to [illegible] stage, and at maximum lift it is said to be the hig[illegible] lift lock in the United States. The gates are 30 ft. wide, 59 ft. high at the lower end and 37 ft. high at the upper end of the lock; the lower gates weigh 130 tons. The river wall of the lock is 630 ft. long and has a greatest height of 60 ft. On the east bank are the power house and transformer house; landward of the transformer house the river crossing is completed by an earth embankment with concrete corewall. Between the power house and lock is the dam itself, 1200 ft. long and 65 ft. in maximum height. The dam section has a crest width under the revised design of 11½ ft. The upstream face is vertical and the downstream face slopes 4 on 3 (horizontal). The extreme depth of concrete below crest level ranges to 83 ft., according to the required depth of caisson sinking to get sound foundation. A longitudinal gallery runs through the upper part of the dam; this is not only for inspection purposes but also for carrying electric conduits, as the lock gates on the right bank will be operated by electric power carried from the power house through this gallery.

The power and transformer houses form the easterly part of the dam. The power house is planned for seven bays, each to contain two power units of 3400-kw. capacity. Each unit consists of three wheels on a vertical shaft 94 ft. high, on top of which is the revolving element of the alternating-current generator. The two lower wheels are 72 in. in diameter, and the upper one 63 in. in diameter. Under low-water condition, that is, with

FIG. 3. CAVITIES IN BANGOR LIMESTONE ALONG TENNESSEE RIVER NEAR HALES BAR

high head of water, only the two lower wheels will be used. The whole revolving weight is carried on oil-flotation bearings. The generator voltage is 6600.

In the river pier of the power house a sluiceway 9x13 ft. is built to provide for a discharge of 5000 cu.ft. per sec., approximately the minimum river flow. This was required by the government with a view to supplying the normal river flow when the turbines are out of use.

The transformer house (for 44,000 volts transmission ...age) is practically all outside of the river channel. ... is constructed of steel frame and reinforced concrete ... is founded on concrete columns 4 ft. and 5½ ft. in ...meter by 55 ft. high, almost all below ground surface. The embankment east of the transformer house is ...ut 50 ft. in maximum height.

### Government Supervision

The arrangements for supervision were rather unusual. As the dam is on a navigable river, the U. S. engineer officer of the district had control of all parts of the work that could in any way be considered as affecting navigation and the power company's engineer had exclusive supervision of all other work. Under this division of responsibility the government engineer had a Junior Engineer with a staff of inspectors on the work. These were supposed to issue their orders to the contractor through the power company's engineer, but for convenience orders were given direct to the contractor. Further, the power company maintained only a small inspection force, and as a result the government inspection force took care of the largest part of the work. A far higher grade and more expensive class of work was done in consequence of this arrangement than would otherwise have been necessary or have been built.

### Construction Work

Construction of the dam and associated works began in October, 1905. W. J. Oliver, Knoxville, Tenn., was the contractor. After a little more than two years he was followed by Bailey & Dumary. This firm also worked for about two years, and after them W. H. Flaherty carried the job on for about six months, until June, 1910. At this time, nearly five years from the time of beginning, no part of the overfall dam itself was completed, but part of the power house and some more of its foundation had been constructed, the embankment at the east end was well advanced, much of the transformer house was built, and the lock on the west bank (on solid rock) was largely finished. Coffer-dams had been built around the power house where it extended into the river, and around the immediately adjacent portion of the dam site. They could not be pumped out or kept dry, however, and the attempt to reach sound and dry foundation in the river had practically failed. The badly broken and seamy nature of the rock had been discovered, and drilling holes in the river bottom and injecting grout to fill the crevices in the rock was tried, without complete success.

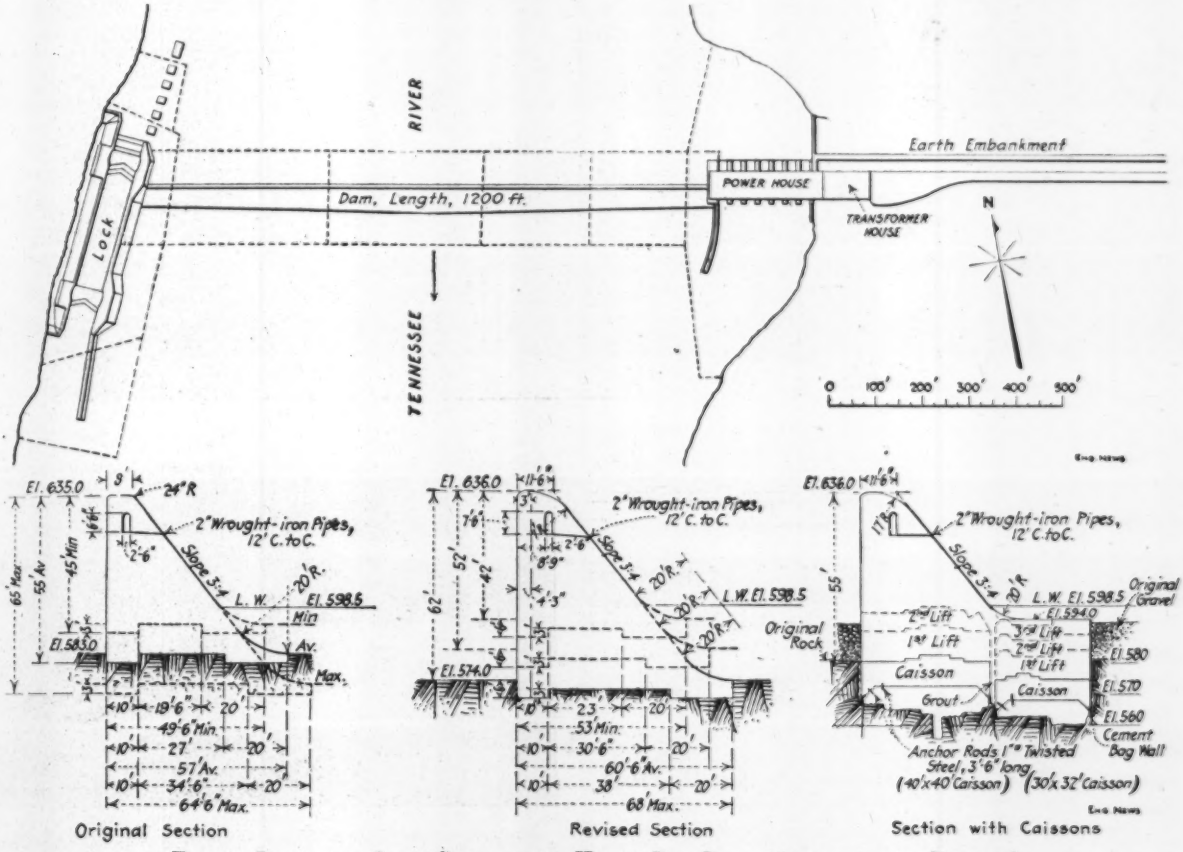



Fig. 4. Plan and Cross-Sections of Hales Bar Dam (Original and Revised)

In June, 1910, the consulting engineering firm of Jacobs & Davies, of New York, was engaged to continue the work at the owner's expense. The firm has carried on all the operations at the site since that time, and by August, 1913, had completed the last part of the dam foundation. On Nov. 4 the last concrete was placed, completing the undertaking. The difficulties growing out of the nature of the river bottom were successfully over-

come, but only by the adoption of radical methods and at great expense.

How the problem of getting a dam foundation was handled is briefly stated in the following summary.

### Rock Grouting and Exploration

In June, 1910, the condition of the rock forming the bottom of the river was not yet fully known, at least for the west half of the river bed. It was thought possible that properly and thoroughly conducted grouting could seal and consolidate the rock and close the leakage.

Easterly End—For both grouting and exploration purposes, twelve well drills were set to work on the power house and the easterly part of the overfall dam (Sections 1 and 2, the whole dam being divided into four sections numbered from the east or power-house end). Holes 6 in. in diameter were drilled to 20-ft. depth in the floor of the coffer-dammed area, and after piping the holes the coffer-dam was flooded and grout was forced through the pipes into the fissures by compressed air. This work covered five or six months, the latter part of 1910, and consumed 11,750 bbl. of cement. It resulted in reducing the flow of water greatly and made it possible to excavate and attempt to get down to a hard foundation stratum. But in spite of the thoroughness in grouting, the removal of rock often would uncover new fissures and require resumption of drilling, flooding and grouting. Further, it developed that crevices in the dam foundation were connected with crevices in the power-house foundation, conclusive proof being obtained by the use of permanganate of potash. The great extent and ramifying nature of the fissuring was becoming more apparent.

In the drilling and grouting, the usual procedure when the hole was completed was to try compressed air in it so as to give some indication of its extent. Then, to prevent waste of cement and loss of the hole in case it would not take grout in spite of taking air, water was pumped into the hole to clear it. Finally, the grout was forced in, charge after charge, always using the smallest pressure that would clear the mixer. Generally, the first charges went in very easily but successive charges required higher and higher pressures as the cavity got filled, up [illegible] available maximum of 75-80 lb.

The power-house foundation, except a small ar[illegible] or two isolated piers—that had been constructed [illegible] contractors, was finally secured by a combination [illegible] campaign of open grouting and grouting under a bl[illegible] ing layer of concrete. When the power-house exca[illegible] had progressed some 25 ft. into the fissured lim[illegible] rock by very careful blasting, alternating with d[illegible] and grouting, the rock surface was judged su[illegible] for foundation and a 2-ft. base of concrete was [illegible] deposited. In this concrete were embedded [illegible] pieces of pipe (Fig. 6) for further test drilling and [illegible] grouting, as it was desired to make sure that no [illegible]

Fig. 5. Drilling in Section 4. Pipes Seen in View Are Ready for Grouting; More Being Drilled

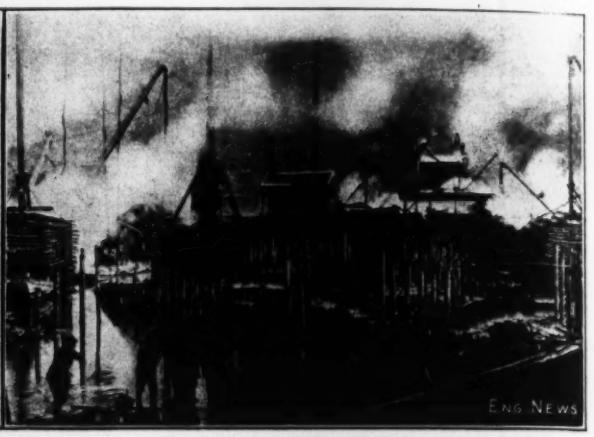



Fig. 6. Section 4 Pumped Out after Grouting

Figs. 5-7. Inside the Hales Bar Coffer-Dams During the Grouting Operations

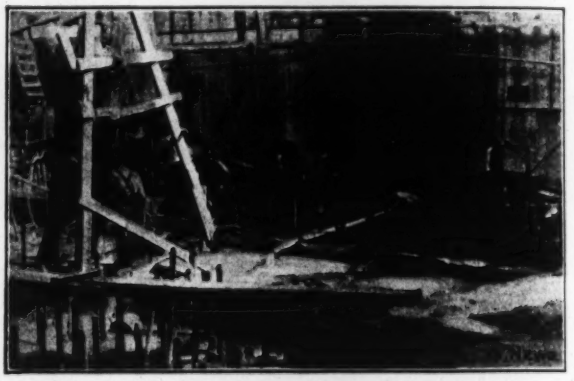


Fig. 7. Grouting Pipes through 2-Ft. Layer of Concrete in Power-House Foundation

or water-bearing seams and no extensive streaks of soft material remained underneath. The value of the concrete base slab was that it suppressed the leakage of water so that it was not necessary to flood the pit when grouting. The procedure followed in this portion of the work was to force water under high pressure into the hole after drilling, or water and air alternately, in order to wash out the fissures in the rock; grouting was not started until the water from the crevice ran clear. The operation was slow and expensive; it continued for four months before the foundation was accepted by the government officer, and one time during this period so many of the grouting pipes stood up out of the concrete in the power-house section that there was hardly room to place a drill tripod.

Ultimately, the continuance of drilling and grouting succeeded in securing the power-house foundation and nearly all of Sections 1 and 2, leaving only a small part at the river end of Section 2. This was the status in the spring of 1911. Prior to this time, work had begun also at the west end of the dam, and here it had gradually brought matters to a turning-point.

Westerly End—At the beginning of Jacobs & Davies' work it was decided to start at both ends of the river, partly to save time (in view of the long delays that had already occurred) and partly to permit attacking the midstream portion of the dam (Section 3) from both ends. Therefore, additional plant was provided and complete working equipment set up on the west bank and the cofferdamming of Section 4 was begun. Exploratory drilling, to be followed by grouting, was started as soon as possible.

The character of the bottom rock proved to be very much worse than that on the east side of the river. The fissuring was more extensive and the cavities and crevices were filled with clay which prevented grouting unless the clay could be washed out. However, a campaign of drilling, washing and grouting was begun vigorously (Fig. 7) and continued until work was stopped by the winter season (1910-1911). It was resumed in the spring and continued energetically for some months, at the request of Major Harts, U. S. District Engineer, although the constructors had by that time lost hope of accomplishing the sealing of the rock thoroughly enough to satisfy the exacting requirements of the government engineers, by this method.

Some progress was being made in these spring months on the east bank of the river, in Sec. 1 and 2, and this progress in part stimulated the hope of accomplishing something in Sec. 4, but in part also acted in the opposite direction by showing how great an expenditure of time and money was required to find and seal with grout all the crevices in the much broken strata of rock.

In June, 1911, the constructors reached the conclusion that they would have to abandon the attempt at grouting in the westerly portion, and resort to the compressed-air caisson method of foundation for constructing a tight cutoff down to reliable solid rock. An obstacle in the way of acting on this decision lay in the fact that the Government specifications for the dam enterprise required all foundations to be secured "in the open," this phrase being interpreted by the District Engineer to rule out the caisson method except under special permission from the Chief of Engineers at Washington. Application was at once made to Washington, but six weeks of the best working season (the low-water period) were thus lost, except a week or two necessary for assembling of compressed-air plant. The ultimate decision was favorable, and caisson work was promptly initiated and pushed forward with vigor; but by this time the program of construction, which had regard to the dry and wet seasons, had been badly upset.

The net result of the drilling-and-grouting campaign therefore was that after many difficulties the power-house foundation was extended to its westerly edge and sections 1 and 2 of the dam itself were ultimately secured. There had been a great expense of time and cost, and in the light of the acquired knowledge of the rock conditions it had become certain that in Sec. 4 and 3 the original method would fail.

### Sinking Caissons for the Dam Foundation

The rock under the dam site did not need to be excavated deeply, to reach strata possessing satisfactory bearing power. But under such strata might be clay pockets or threads, and open fissures, whose influence on the stability of the dam is perhaps debatable. Further, the future dissolving effect of the water carried in some of the seams was an important psychological factor. Apart from such future effects, there was the mechanical problem of getting a solid dam structure substantially connected with firm rock. The flow of the springs blocked all attempts to obtain such connection, or to determine when firm rock had been uncovered. The caisson method gave assurance of answering all the difficulties, by making excavation feasible under all conditions, permitting full examination of the strata reached, furnishing solid connection to the rock, and forming a tight cutoff. Therefore caissons were used covering the whole base area of the dam.

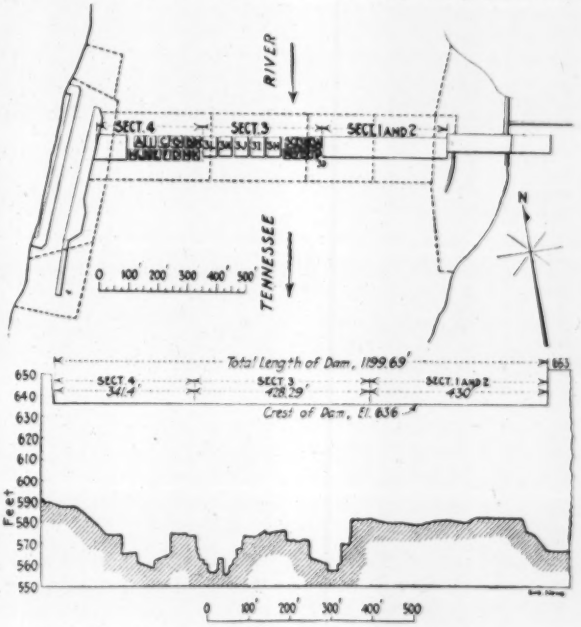



Fig. 8. Plan of Caisson Arrangement, and Profile of Dam

The dam as built may therefore be said to extend from crest level down to caisson bottom, the latter being the base of the dam. Its cross-section does not correspond to a dam of such height, since the caissons are seated tight in the rock and merely replace part of the rock by a denser and stronger substance. The thickening of the dam section already mentioned, which was recommended and adopted about this time, was due largely to the fact that the surface of rock dipped a little lower at the deepest part of the river than had been assumed previously, so that adequate design on the basis of gravity principles required a broader base.

Caisson sinking was begun in Sec. 4 and carried eastward, and also (Sec. 3-A) at the westerly end of the foundation secured by the grouting method and carried westward. It finally closed in the remaining part of Sec. 3, the middle and deepest part of the work (Sec. 3-B). The caisson layout is shown in Fig. 8. As may be seen there, the early part of the work employed caissons of moderate

size, each approximately as wide as half the width of the dam, so that two rows of caissons extended along under the dam.

All joints between caissons were, of course, filled with concrete after the caissons were filled, and similarly whatever spaces were formed between the sides of the

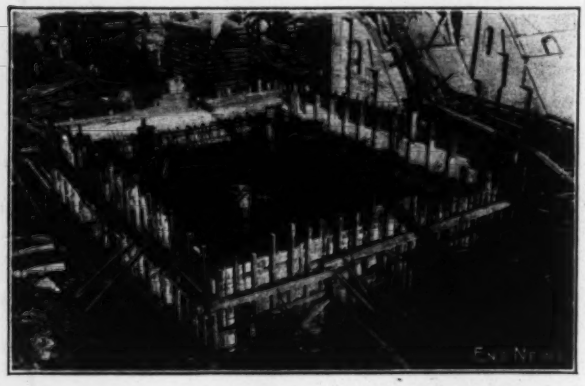


FIG. 9. FORM AND LOWER REINFORCEMENT FOR ONE OF THE LARGE CAISSONS

caissons and the abutting rock were thoroughly grouted to give complete continuity of bearing. Later in the work it was found more advantageous to sink larger caissons, making each caisson of such width as to extend from heel to toe of the dam.

The earlier caissons were: in the upstream row 40x40 ft., in the downstream row 30x32 ft. These were used in Sec. 4 (14 caissons) and in Sec. 3-A (7 caissons). Late in 1912 it was decided to make the closure, Sec. 3-B, by the larger caissons. These were built 72x54 ft., and five of them were required to close the gap. Thus there are in all 26 caissons under the dam.

All caissons were built of reinforced concrete, with cutting-edges of ½-in. and ⅝-in. steel plates. The working-chamber was made 4½ ft. high and the concrete roof 8 to 12 ft. thick. The small caissons had two shafts through them, a material shaft and a man shaft, besides a number of pipes for blowing out water, passing in long drill steels and grouting; the large ones had 4 muck locks and 2 man locks. Air locks similar to those used in the caissons of the east approaches to the south tunnels of the Hudson & Manhattan Ry. at New York City were employed; the bucket is hoisted by a rope running through a stuffing-box in the shaft cover and is discharged through a side door, returning at once to the working-chamber.

None of the caissons were sunk in the open river, but all the work was done inside the protection of coffer-dams. The most important reason for this was that as the power house and easterly portion of the dam already obstructed the river on the east side, as did the lock on the west side, flood flow was concentrated through the section in which work was being done, and therefore a caisson in the open water would be so much in danger as to make the protection of coffer-dams advisable. Sections 1, 2 and 4 having already been inclosed, Sec. 3 was the only one in which any question as to coffer-dam construction arose. It was inclosed with crib coffers like those of the other sections, except that they were built to an elevation 8 to 10 ft. higher, throwing the river flow over to the other sections, whose foundation work was by that time well advanced. Sec. 3 was also filled with gravel and other material to a point above low water so that the caissons could be built on solid ground at an elevation where the pumps were able to control the water and work could go on during high-water season.

The caisson sinking proceeded on the general plan described, without exceptional difficulty. The highest air pressure used was 25 lb. per sq.in., and three 8-hr. shifts could be worked at all times, except that every other Sunday (day after pay day) was idle; floods, of course, stopped the work completely from time to time, the total time lost this way being 185 days in 18 months.

The character of the rock improved with depth, and while much air was lost (mainly because of the necessity of excavating rock below the cutting-edge) it at no time introduced serious conditions, and the leakage was generally reduced by dumping clay over the largest leaks showing on the surface of the water, and plastering with clay the face of rock exposed below the cutting-edge.

In the excavating work inside the caissons, shallow holes were drilled with small-size air drills, and very small charges of 60% dynamite were used. The men generally simply climbed into the shaft and closed the bottom door during the shooting. Blasting with small charges was done freely close to and directly under the cutting-edge, without at any time damaging it or causing trouble in sticking.

The nature of the rock became more fully evident in the caisson work. In fact the rock strata penetrated were exposed just as fully as in a dry coffer-dam pit, and there was no guesswork as to the actual condition of the foundation secured. In the upper layers the rock was completely separated by crevices into pieces looking quite like boulders, and called boulders by the men,

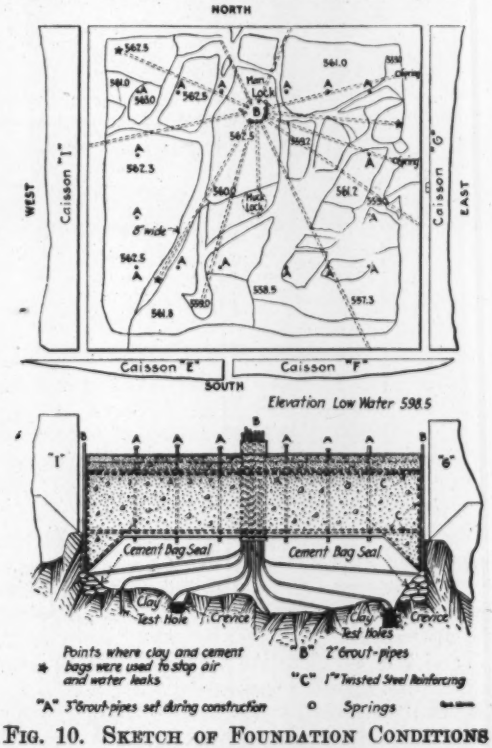



FIG. 10. SKETCH OF FOUNDATION CONDITIONS IN CAISSON C

th gh clearly consisting of limestone rock in place. L r down the separation was less extensive and com- pl , but the word "less" is only a relative term. One

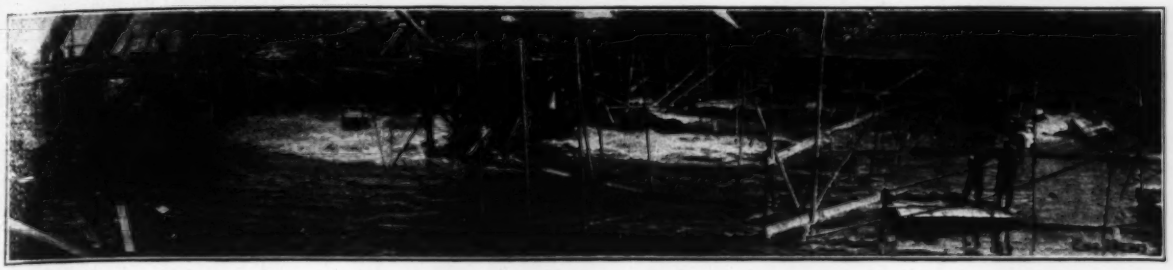


FIG. 11. SINKING CAISSONS FOR HALES BAR DAM
(Work in Section 4. Pipes in place for grouting outside caisson.)

fissure was followed as far as 8 ft. outside of the caisson area, and in another instance a crevice was excavated 14 ft. below the accepted foundation, or 21 ft. below the cutting-edge, the total depth from roof of working-chamber to bottom of crevice being about 25 ft. These are only two instances showing the large extent in some cases of the very numerous fissures and cavities in the rock. It is to be noted, however, that in Sec. 4 and 3 the cavities (except where spring water was found) were filled with dry and hard sand and gravel, always in a matrix of clay.

The determination of proper bottom stratum was left to the Government engineers. They required that holes 8 ft. deep should be drilled below the accepted foundation and should show sound hard rock. As the working-chamber was only 4½ ft. high, this in all cases required the caissons to be hung up a number of feet above the bottom, and in consequence there was much trouble from loss of air through the exposed side faces of rock. The test holes were drilled on a line about 4 ft. in from the cutting edge and 3 ft. apart on this line; some of them were drilled as deep as 20 ft., in which cases the drills worked under the airshaft. All fissures in the final rock floor of the caisson had to be completely cleared out, and the whole rock surface scrubbed absolutely clean; under the Government inspection it often cost more to clean off the rock surface than to place the concrete filling of the working-chamber.

After acceptance of the bottom, the rock was cleared away from under the cutting-edge a short section at a time (to avoid loss of air), and a wall of bags of cement built up from floor to cutting-edge. Then the inside face of this bag wall was plastered with a stiff cement mortar, and filling the chamber begun. The concrete was handled into the chamber in this work by dropping it down the airshaft, using the upper and lower doors alternately. A door farther up in the airshaft was also provided for use as lower door in the last stage of the filling, when men no longer had room to stand and work in the chamber. As the working-chamber had a level ceiling, it could not be filled direct, snugly to the ceiling, but had to be grouted subsequently through pipes left in the caisson.

Sealing the spaces between the caissons was done by various methods. Spaces which were too narrow for men to enter were first cleaned out as thoroughly as possible at the top, then a concrete cap put on and grout forced in with high final pressure to fill all crevices. In longer continuous spaces sections were separated off by sheet-piling, pumped out, cleaned and excavated either by hand or by streams of water, and finally concreted, with pipes set into any exisfing fissures and brought up to the surface for final grouting. In a number of the spaces it was found best to put on a concrete cap between the caissons and build a lock into the cap so that the space could be excavated and cleaned under compressed air. At first adopted as a necessity, in a few cases where the leakage of water could not be controlled, the method was found so advantageous that in the five closing caissons (the large caissons) the spaces were intentionally made 24 in. wide with a view to using this method of closure.

The last of the caissons in Sec. 3-B was finally bottomed and filled in August, 1913, reaching a depth of 45 ft. below low-water level. This is the maximum depth attained on the work.

The operations above the foundation, that is, the concrete construction of the dam and the remaining construction work, proceeded without particular difficulty or incident.

The upper part of the dam was built in alternate high blocks carried to the crest and 20-ft. open spaces with bottom at El. 600, which is zero on the gage. When the dam in sections 1, 2 and 4 had been built in this alternate arrangement, section 3 was surrounded with coffer-dam and the river flow was passed through the openings in sections 1, 2 and 4 (previously the flow had been passed through Sec. 3, the other sections being inclosed in coffer-dams). There were 20 of the 20-ft. openings. They passed the river satisfactorily except in the winter high-water periods. In the flood periods the whole work was submerged sometimes under 33 ft. of water; on one occasion the river rose to 33.3 ft. on the gage. The dam superstructure in Sec. 3 was built during 1913, and, of course, was carried solid to the crest, i.e., without openings. It remained to close the openings in the other sections.

Suspended forms were placed in the 20-ft. openings after Sec. 3 was completed, and the *upper parts* of the openings were concreted, leaving sluiceway openings 20 ft. wide by 13 ft. high. These were closed on the upstream side by steel shutters built of 15-in. I-beams and steel plates lowered over the opening of the sluiceway. On each side of the shutter there were five rollers to prevent friction between the concrete and the shutter. The closure was sealed in some cases by calking with a 1½-in. cotton rope, done by a diver, but more generally the seal was made by a 3-in. linen fire-hose laid in a half-round recess in a 12x12-in. timber around the inner edge of the shutter; the hose was inflated with water under 65 lb.

pressure after the shutter was lowered to place. Both methods answered well. When the shutter was sealed to the dam the sluiceway was filled with concrete. Three or four openings were concreted in a week's work, under this procedure.

This work has been carried out with Thomas E. Murray as Consulting Engineer and Col. John Bogart, of Bogart & Pohl, as Chief Engineer, and on behalf of the War Department under the supervision of Major Harry Burgess, Corps of Engineers, stationed at Nashville and in charge of Nashville and Chattanooga Districts of the Central Division, assisted by Capt. R. C. Moore, Corps of Engineers, stationed at Chattanooga.

The actual construction and the design in connection therewith has been carried out by Jacobs & Davies, Inc., who were represented by James Forgie as visiting member of the firm in charge of the undertaking, with Charles J. Crowley, Superintending Engineer, as their representative on the ground.

## Irrigation Water-Supply for the Pima Indians

By Arthur P. Davis*

The problem of furnishing water to the Pima Indians on the Salt River Reservation, Sacaton, Ariz., has engaged the attention of various Government engineers for nearly twenty years. A special investigation by the writer was made in the winter of 1896 and tests were made of the yield of underground waters and surveys were made for water storage on Queen Creek and Gila River.

Owing to the high price of fuel and the lack of any supply of cheap power, the pumping proposition was rejected and recommendation was made for an ap-

Fig. 1. Egyptian Long-Fiber Cotton Grown by a Pima Indian on Irrigated Land

propriation to make borings and other examinations for water storage on the Gila River.

In 1898 Congress appropriated $20,000 in accordance with this recommendation and the writer undertook investigations at various points on the Gila River, known as the "Buttes," "Riverside," and "San Carlos." Before these investigations were completed, the writer was ordered to the American Isthmus to take charge of the water-supply investigations in the Nicaragua and Panama Canal routes and the work was turned over to the principal assistant, J. B. Lippincott, who completed the investigations and prepared a report which was published as Water Supply Paper No. 33, of the U. S. Geological Survey. Mr. Lippincott recommended the construction of a reservoir at San Carlos.

After the passage of the Reclamation Act requests were made that the San Carlos Reservoir be built from the Reclamation Fund for the benefit of the Indians, but this could not be done under the then existing law.

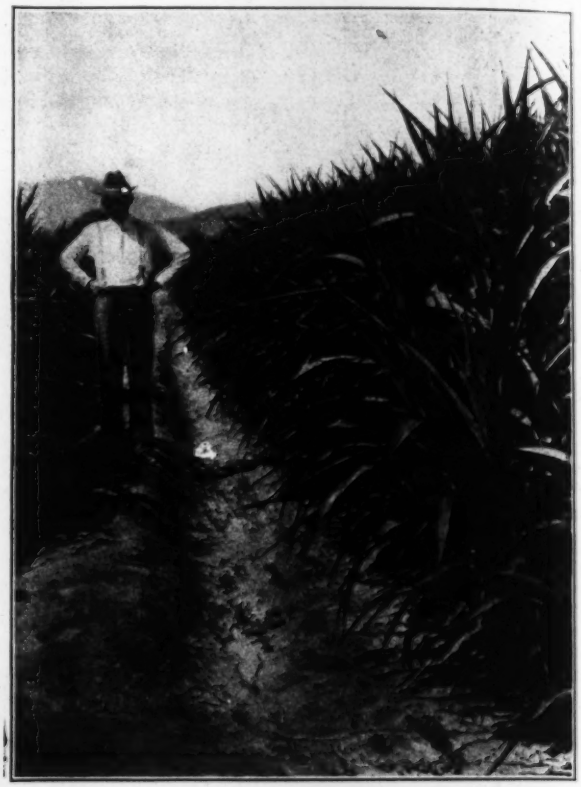


Fig. 2. Irrigated Cane Sugar on Sacaton Indian Reservation

These requests for water storage on the Gila River were urged mainly by the inhabitants of the Casa Grande Valley, by whose diversion of the waters of the Gila the Pima Indians have lost their ancient water-supply, but who had in turn been deprived of this water by diversions still higher up in the neighborhood of Solomonsville and Safford.

The Chief Engineer of the Indian Service, Mr. W. H. Code, investigated the subject and decided that the best solution of the water-supply for the Indians was by pumping from wells at and near the Reservation, this water to be used to supplement flood waters diverted from the river by large canals. Cheap power was made available by the construction of the Salt River project and the power development incidental thereto.

Naturally, the people who expected to benefit by the provision of storage on the Gila River opposed this pumping scheme, but it was authorized by Congress and an appropriation was made to provide the flood-water canals, sink the necessary wells and equip them with pumps and motors. A vigorous campaign was started to prevent the

*Chief Engineer, U. S. Reclamation Service, Washington, D. C.

use of these wells by attacking the quality of the water. It was claimed that it was so charged with alkali that it would ruin any land to which it was applied. A considerable degree of success was attained in arousing the fears of the Indians and for about a year the works provided by the United States were allowed to lie idle and to depreciate. Last spring, however, an energetic and sympathetic management was installed at Sacaton; the works put in order, and some of the Indians were induced to use the water in agriculture.

Fig. 1 shows a crop of Egyptian long fiber cotton grown by a Pima Indian on the Sacaton Reservation, irrigated from the Government wells. Good judges estimate that this crop of cotton will return a net income above the cost of picking and marketing of $75 per acre. It should be remembered that cotton is peculiarly sensitive to alkali.

Fig. 2 shows a crop of cane grown on land near Sacaton, which contained such an excessive quantity of alkali that from time out of mind it had produced nothing and had been abandoned as worthless. The land was leveled, diked and heavily flooded four times with water supplied from the Government wells. The heavy crop of cane shows the success of reclamation, and next season this land will be planted to alfalfa. The results in the vicinity of Sacaton have demonstrated the suitability of the water for agricultural use and have doubtless gone far to remove the prejudice of the Indians.

## Tunnel Construction on the Willamette Pacific R.R.

The Willamette Pacific R.R. is a new line which is being built by the Southern Pacific Co., from Eugene to Marshfield, Ore. Tunnel No. 1 has been completed recently, and for particulars of its construction we are indebted to Mr. Hood, Chief Engineer of the Southern Pacific Co.

The tunnel is 2480 ft. long and pierces the Coast Range Mountains between the Willamette Valley (which drains into the Columbia River) and the Siuslaw River drainage, which empties into the Pacific Ocean. The work has been done by the Twohy Brothers Co., of Portland, Ore., under the direction of Mr. Hood, and under the local supervision of H. P. Hoey, Assistant Engineer, Southern Pacific Co.

The contractors got on the ground in November, 1911. The north approach cut was taken out in December, and a 6x6-ft. drift was started about Dec. 23, 1911. This drift was carried underground for 72 ft., and then the heading was widened to the full timber section of 8x17 ft. Excavation was started in the bench about Jan. 20, 1912. The material encountered, both in heading and bench, was a soft, blocky sandstone which broke in good shape. Timbering was kept up with the excavation for 118 ft. For the first 60 ft., temporary timbers were used, as it is the intention to use a masonry section for that distance; also a masonry portal will be used. The permanent timbering is the railway company's standard, and of the independent set type.

At a distance of 118 ft. sandstone was struck. This material showed no seams and carried very little water. Fair progress was made through it, averaging about 28 ft. per week. At 320 ft. a clay and earth seam was struck which carried considerable water, and although it extended only 78 ft., it delayed progress considerably. At 667 ft. a slate seam about 5 ft. thick was encountered for a distance of 278 ft. This seam lay nearly horizontal to the roof of tunnel, but with a slight downward slope. All the way through this seam it was necessary to timber up to the breast of the excavation as well as to keep timber up in the heading.

With the exception of the two places mentioned above the material encountered was of a hard sandstone formation which was inclined to break blocky. For this reason the contractors found it to be economical to drill more holes than usual and shoot the material hard, breaking it up small enough to be handled with a steam shovel.

Owing to the wet winters in this locality and the general bad condition of the roads, the contractors did not get their plant installed until the middle of April, 1912, so that the first 320 ft. of the tunnel was hand work. The plant installed is of small capacity. Four 35-hp. portable locomotive-type boilers mounted on trucks (and working under moderate draft) operate a 100-hp. horizontal engine which drives a compressor having a capacity of 440 cu.ft. per min. The lighting plant consists of two dynamos of 38 and 48 amp., each directly driven.

Owing to certain unfavorable conditions the contractors did not get started on the south approach cut until October, 1912. This cut is about 800 ft. long and lies in the bottom of a drainage area in springy ground. This springy ground was also the cause of a slide on the left side of the cut at the point where the slopes were highest; the earthy material lying on top of the ledge sliding on the ledge into the cut. This slide broke back at a distance of about 165 ft. from the center line and for a length of about 300 ft.

In order to drain the ground in the vicinity of the portal, and keep the water from the drainage away from the portal and out of the approach cut, it was necessary to build a dam about 300 ft. upstream from the portal and to divert the water in a ditch and flume. This carried it above the top slope of the approach cut for a distance of about 1200 ft. before returning it into the approach cut, where it flowed along the roadbed in the surface ditch at the toe of slope and thence out of the cut.

The contractors did not get underground at the south end until July 26, 1913, and by working double shift drove 233 ft. of heading in one month. The headings met Aug. 27, 1913, and the bench was removed Oct. 6, 1913. The bench, however, has all been taken out from the north end, the muck being hauled about 3000 ft. with mules and cars.

One shaft was sunk by the contractors to provide air and carry off smoke. This air shaft would not have been necessary, however, had they got underground from the south end at an earlier date.

For the greater part of the distance through this tunnel it was not necessary to keep the timbering up to the breast of the excavation. Under these conditions it was most economical to wait until there was sufficient excavation ahead to keep the timber crews busy. This was done, and back timbering is now proceeding and should be completed by the time the work is cleaned up and the contractors' tracks are removed.

The rate of progress has been very uneven; the best week's progress being 65 ft. Taking the work as a whole, for a total of 625 days (excavation of bench started Jan. 20, 1912, bench completed Oct. 6, 1913), the average progress would be 3.95 ft. per day.

# Provincial Public Works Organization of the Philippine Islands and Its Engineering Personnel

By E. J. Westerhouse*

The engineering work for the 31 Christian provinces of the Philippine Islands, as directed by division and district engineers of the Bureau of Public Works, is of unusual interest in view of the special conditions prevailing in the Islands.

Aside from the City of Manila, the 703 other municipalities of the archipelago are without city engineers. Nor is there in any of these municipalities an engineer engaged in private practice qualified to be employed on municipal engineering work.

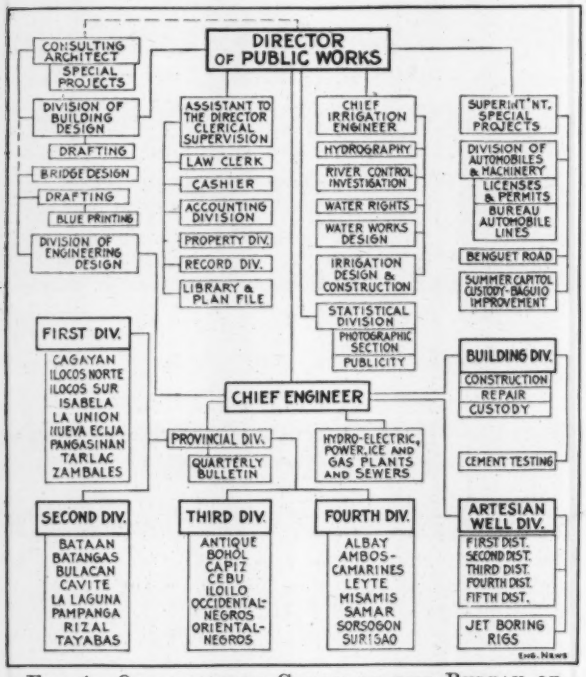



Fig. 1. Organization Chart of the Bureau of Public Works, Philippine Islands

All engineering projects, for both provinces and municipalities, must, therefore, come under the direct supervision of the district engineer organizations of the Bureau of Public Works. These are distributed over 60 islands, and groups of islands, with areas varying from 50 to 122,346 sq.km.

Labor conditions and transportation facilities differ in each case, many of the projects being accessible only with the greatest of difficulty. This, in a large measure, accounts for the fact that private contracting firms are bidding on less than 25% of the public-works projects.

The Bureau of Public Works is consequently called upon not only to design but to carry out the actual construction work of all those projects not readily accessible, representing 80% of the whole, on which no advantageous bids are received.

To accomplish this end the bureau has been constituted a government contract agency, executing the work on an "actual cost plus a fixed percentage" basis, 8% on insular projects and 6% for provincial and municipal projects. These percentages cover the cost of administration for the central organization of the bureau. The engineering expense of the district organization for each province is covered in a like manner, the percentage being governed by local provincial conditions, with an average of 7%.

The district organization is charged with the actual execution of all work, the district engineer representing the Director of Public Works. The average number of projects active at any time for the 31 engineering districts is approximately 620. This is equivalent to 20 projects in active operation for each district engineer every day in the year.

Each project represents an expenditure of from $250 to $250,000, with the responsibility in most cases the same; many of the projects are accessible only at the expense of considerable time and energy. Were the district engineer to give each project the time required for investigation and inspection in keeping with good engineering practice, the 24 hours of the day would be more than occupied.

Trials and Tribulations of a District Engineer—His responsibility not only involves correct location, sufficient design and economical prosecution of construction work, but also includes cost accounting, property accountability in its severest form, and a multitude of administration matters. He relies on local native help for his office administration and is held "personally liable" for exceeding in expenditure the funds available for any one project. Small tools and supplies are of necessity issued to irresponsible laborers, or delivered to unknown transportation agents for shipments to all parts of the district; and for these tools he is also held responsible.

Surveys and investigations must be sufficiently extensive for securing the most feasible location consistent with permanency and a reasonable cost. When construction is actually undertaken, difficulties of every description arise.

In most lines of industry, an organization is a gradual growth built up through years of effort. Each man performs a certain work, his duties are similar to those he performed last month or last year. Under such conditions even common labor develops a certain dependable efficiency.

With the district engineer's work it is quite different. Seldom are the same laborers employed on one project for more than a few months. Some work a few days, some a few weeks, but every day the force changes. Skilled labor of every art and trade, including carpenters, masons, blacksmiths, riveters, divers, plumbers, roofers, steam engineers, etc., goes to compose the force required for district work. Lack of labor causes delay, and failure to keep labor supplied with material and equipment means loss of time and money.

Practically all supplies are requisitioned from a central government agency, and delay in filling such requisitions, broken promises, labor troubles and transportation problems all combine to test the resourcefulness and ingenuity of the engineer responsible for the economical prosecution and successful execution of the work. Only men of strong character can stand up under this strain.

*Chief Division Engineer, Bureau of Public Works, Philippine Islands, Manila, P. I.

DEVELOPMENT OF THE PUBLIC WORKS ORGANIZATION.—Upon the organization of civil government in the Philippine Islands the only provision made for engineering supervision over public works was under Act. No. 83, effective Feb. 6, 1901, creating the position of provincial supervisor, the occupant of which was to be a member of the provincial board and under the general direction of the Executive Secretary.

Although the Philippine Commission on Aug. 7, 1902, passed an act creating the position of consulting engineer to the Commission, it was not until Jan. 8, 1903, when an act was passed giving the consulting engineer supervision over provincial supervisors on all engineering work. All public works for the Philippine Islands were prosecuted under this organization up to Jan. 1, 1906.

smaller provinces, men could not be secured to fill these positions and the duties of the supervisor's office were taken over by the provincial treasurer.

This readily accounts for the small amount of work of a permanent nature accomplished during this period on roads, bridges, buildings and other public works. At the same time the amount of funds available was inadequate for undertaking large projects, the total expenditure for the three years ending June 30, 1905, being $1,707,500.

There had been no policy promulgated by the central office for the prosecution of public works along approved lines. Road locations, bridge and building plans and estimates, for the greater part, were prepared for each province by the lone supervisor without opportunity for advice or consultation with other qualified engineers.

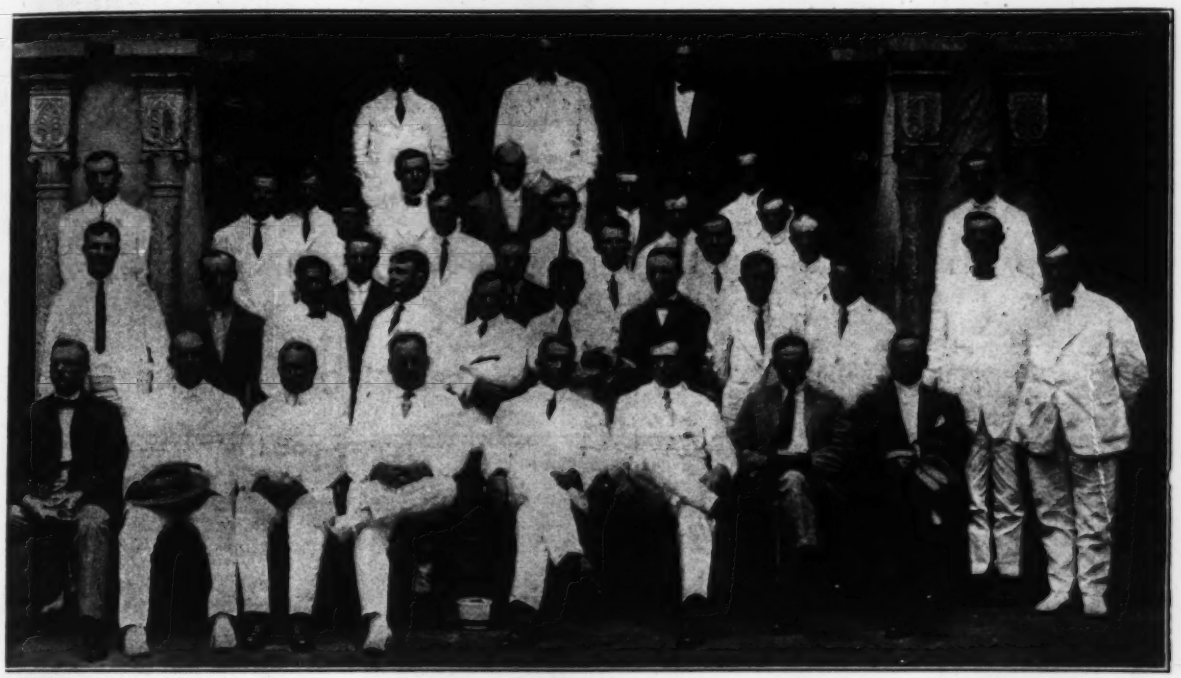


FIG. 2. GROUP OF DIVISION AND DISTRICT ENGINEERS, BUREAU OF PUBLIC WORKS, PHILIPPINE ISLANDS

Assistant to Director, C. Lindsey; Warwick Greene, Director; E. J. Westerhouse, Chief Division Engineer.
Division Engineers:
D. E. Henry. E. P. Shuman. H. F. Cameron. W. H. Waugh. B. Von Schmeling.
District Engineers (standing): L. W. Scheidemantel, J. W. Graham, S. Baluyot, E. D. Smith, L. S. Boggess, M. Kasilag, E. E. Schenk, J. Vallarta, R. Agcaoili, A. W. Austin, C. R. Bennett, W. F. Root, J. C. Carpenter, C. G. Morrison, R. L. Barry, J. R. Barry, R. W. Randolph, A. T. Sylvester, J. G. Beckjord, H. A. Raider, R. N. Allen, L. T Clark, E. C. Brown, O. N. Powell, R. V. Glenn, J. H. Caton, J. A. Harrison, H. R. Meahleib, W. C. West, C. F. Vance, R. A. White, H. K. Davis.

Under this last act no provision was made for direct technical supervision and inspection, all provincial and municipal public works for this period being entirely under the direction of the provincial supervisors without technical help. The provincial supervisor was a member of the provincial board, which occupied a large part of his time with administrative matters, and he was also responsible for all provincial property and the handling of supplies for all municipalities, which left very little time for either supervision or inspection.

This class of work did not appeal to trained engineers and as a result positions of supervisor, for the most part, were filled with men of more or less practical experience but with little technical training. For many of the

These conditions largely account for the fact that the roads constructed, with very few exceptions, were not of an approved cross-section; for the most part they were constructed for a single-line traffic, without a hard and endurable surface and without regard as to location, gradient or the real needs of the country. Provision had not been made for systematic and effective maintenance on either roads, bridges or buildings, although a few substantial buildings were erected and occasional short sections of first-class road were constructed. It is estimated that the value of permanent construction work remaining as a result of operations for this period does not represent more than 10%, or at most 15%, of the total expenditure on public works.

During this early part of American occupation it was practically impossible to secure skilled workmen, and the common native laborers had not been trained along lines of modern construction methods. Through the ravages of war and disease, approximately 90% of the working animals had been lost, which made the question of transportation of supplies and materials for public works a very serious one. These were some of the problems which the engineer was called upon to solve.

The insular authorities were soon brought to a realization of the necessity for a stronger central control over the engineering personnel engaged in the prosecution of public works. Act No. 1401 was consequently passed, dividing the 31 Christian provinces into engineering districts with complete supervision by the Bureau of Public Works. The first district apportionment was made on the basis of 13 engineering districts with a district engineer and such additional assistant engineers as might be required for each district.

FIG. 3. NATIVE LABOR CONSTRUCTING SUBGRADE WITH CARABAO AND DRAG SCRAPER

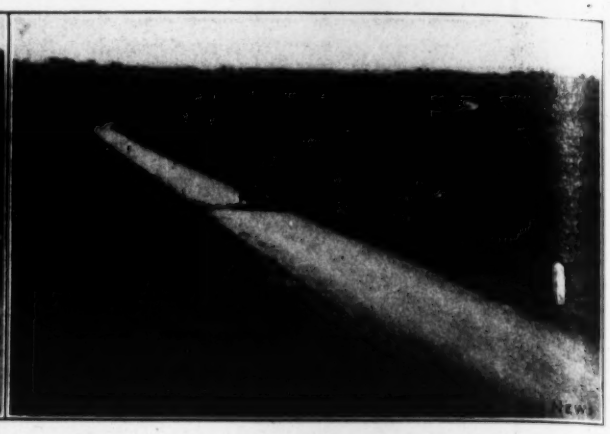


FIG. 4. SECTION OF MANILA SOUTH ROAD

With the beginning of this organization in January, 1906, steps were taken to have all public-works engineering features approved by the Director of Public Works. No provision, however, was made for increasing the revenues accruing to public-works funds, and as no further congressional relief funds were available, the items of construction showed a considerable decrease as compared with previous years. Quality, rather than quantity, was given prime economical consideration. The extent to which the quantities decreased under this order of things is indicated through the following tabulation:

CONSTRUCTION WORK ACCOMPLISHED, 1904-1907

| Fiscal year ending | Kilometers of road | Bridges and culverts | Buildings |
|---|---|---|---|
| June 30, 1904 | 407.0 | 582 | 148 |
| June 30, 1905 | 185.0 | 658 | 154 |
| June 30, 1906 | 71.3 | 124 | 12 |
| June 30, 1907 | 49.2 | 65 | 5 |

That the expenditure on temporary work was justified only as an emergency relief measure became entirely apparent. Practically none of the road work and comparatively few of the bridges and buildings of the period prior to Jan. 1, 1906, now remain.

Through the efforts of the Hon. W. Cameron Forbes, then Secretary of Commerce and Police, a road law was passed known as the Double Cedula Act, whereby one peso (50c.) was levied as a poll tax accruing to road and bridge funds. Through his efforts, a precedent for insular aid on road and bridge betterment was also established, and the real impetus to permanent road and bridge construction work dates from this time.

The total amount of insular aid voted from funds of the Philippine Treasury for provincial road and bridge

FIG. 5. SECTION OF SPANISH ROAD CONSTRUCTION

FIG. 6. SECTION OF MANILA NORTH ROAD

FIG. 7. NEW ROAD LOCATION BENCHED IN SOLID ROCK

FIG. 8. COASTAL ROAD WITH CORAL SURFACING

FIG. 9. OLD SPANISH MASONRY BRIDGE

FIG. 10. REINFORCED-CONCRETE BRIDGE UNDER CONSTRUCTION

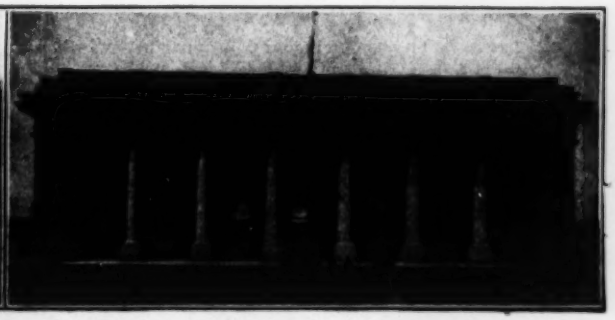


FIG. 11. THE VAUGHN BRIDGE ON THE MANILA SOUTH ROAD

FIG. 12. PROVINCIAL CAPITOL OF THE LA LAGUNA

work, beginning with Act No. 1688 passed Aug. 17, 1907, to Dec. 31, 1912, is $4,660,613. The following tabulation will be of interest, showing expenditures on road and bridge work for the five years, 1908 to 1912, inclusive.

EXPENDITURES FOR PUBLIC WORKS, 1908-1913

| Fiscal year ending | Road and bridge expenditure | Total expenditure under bureau supervision |
|---|---|---|
| June 30, 1908 | $755,220 | Not compiled |
| June 30, 1909 | 1,337,955 | Not compiled |
| June 30, 1910 | 1,525,676 | Not compiled |
| June 30, 1911 | 2,275,866 | $4,941,324 |
| June 30, 1912 | 2,273,354 | 4,860,221 |
| June 30, 1913 (estimated) | 2,375,000 | 5,000,000 |

With the increased revenues it soon developed that the engineering districts as established were too large to permit of successful administration. When this condition became apparent steps were immediately taken to redistrict the Islands, increasing the number of districts from time to time, so that at present each province comprises a separate district with a district engineer in charge. The results which have obtained under this organization entirely justify the present district apportionment.

PRESENT ORGANIZATION AND WORK OF THE BUREAU OF PUBLIC WORKS—During the latter part of 1908, it also became apparent that the salaries paid district engineers for many of the provinces were unattractive to men of technical training, who at the same time had the practical experience to cope with a diversity of engineering problems such as presented themselves in each district. The salaries authorized for district engineers

range from $1500 in the smaller provinces to $3000 in the larger provinces.

To secure public-works projects against common failures, it was, therefore, deemed essential that each district engineer be given the benefit of the experience gathered in other districts. To accomplish this, engineering divisions were created, with a division engineer in charge of each, who constantly makes inspection trips and reports in person to the Director of Public Works. The Bureau of Public Works as at present constituted, therefore, includes four division engineers, each with an authorized salary of $3500 per annum.

Under the direct supervision of the division engineers, and subject to their approval, the engineering field forces are making detailed investigations for all bridge and building structures, including foundation tests, and in case of bridges special investigations are made to determine the type of structure best suited for the location, the elevation required and the amount of waterway to be provided.

The result has been that the buildings and bridges constructed in the provinces during the past three years have stood without one serious failure, notwithstanding the fact that they have been subjected to earthquakes and extraordinary floods. (The maximum rainfall recorded is 45.99 in. for 24 hr.)

Through concerted efforts on the part of district and division engineers an effective "caminero" maintenance system has been established in all the provinces, insuring against the deterioration of all first-class roads. The construction of a road is only recommended after its productive value has been determined from a traffic census, giving due consideration to the amount of productive territory actually under cultivation, the total population to be benefited, and the class and value of products dependent upon the road as an outlet to market.

The standard for approved construction has been raised from time to time so that 80% of the kilometerage of designated first-class road now represents highway construction along scientific lines with a hard and durable surface, properly drained and of sufficient width to accommodate modern traffic requirements. On June 30, 1908, there were actually designated as first-class a total of 395 kilometers of road. This had been increased on June 30, 1913, to a total of 2071 kilometers.

The bridges constructed under American administration prior to Dec. 31, 1905, which continued to be serviceable on Dec. 31, 1908, were valued at $236,693. On Dec. 31, 1912, the number of permanent structures, not including those of Spanish construction, had been increased to 3389 with an appraised value of $2,519,000. On the same date, in addition to a number of insular, provincial and municipal administration buildings, jails, markets, etc., more than 148 concrete school buildings had been completed, with 168 similar buildings under construction.

A tabulation of active projects, which on June 1, 1913, were operative under the district engineers' organizations, includes the construction, maintenance, repair and reconstruction of 202 km. of roads, 107 bridges, 10 provincial administration buildings, 9 municipal administration buildings, 3 prisons, 112 school buildings, the construction and operation of 31 markets, 7 parks, 7 miscellaneous buildings, 6 ferries, 11 water-works systems, 1 quarry, 3 telephone lines, 1 electric-light plant, 49 miscellaneous projects such as surveys and investi... s, dikes, bituminous pavements, artesian wells, riv... n-trol, etc. This makes a total of 559 active proje...

The Philippines have entered upon an era of ... s-trial prosperity and as a result, building materi... d other supplies are increasing in cost. Labor and ... s-portation costs are also rising. Notwithstanding ... se conditions, where an opportunity for comparison ... s, it is shown that the public work is being done mor... -nomically under the present organization than a... y previous time. It is therefore apparent that the d... ct and division engineer organization of the Bureau of ... b-lic Works has developed into an effective unit for t... x-peditious and economical prosecution of public wor...

## Solving the Problem of "Human Engineering"

By Fred H. Rindge, Jr.*

"The man is infinitely well worth study and infinitely more difficult to study than the machine." So says Hon. William C. Redfield in a recent article, and he is right. The importance of the human factor in industry cannot be overestimated. Engineers and employers are increasingly realizing that a careful study of this "human factor" pays in dollars and cents, and is worth while in innumerable ways.

As one sees thousands of engineers graduating from our colleges each year, the question naturally arises, "How are these men, many of them coming leaders in their profession, equipped to understand and deal intelligently with the human factor in industry?" Certainly a study of college books or laboratory methods has not given these men any knowledge of this sort. Possibly a small proportion of these graduates have had limited experience in dealing with working men in the summer time but this seems small indeed if we compare the statement of one engineer that "the greatest element in the success of an engineer today is his ability to handle men intelligently and sympathetically."

Here then is a great need, long unmet. There is also another great need—the need for *service* in the industrial world. Between these two needs has sprung up the "Industrial Service Movement," which enlists the college man in volunteer service for the industrial worker, to the mutual advantage of both. The college man teaches a class in English or civics to foreigners, leads a club of working boys, instructs shop men in mathematics and mechanics, talks in a labor union, teaches hygiene and first-aid to men in a factory—in short, does anything that is worth while and which at the same time brings him next to men. In this work he gains an insight into actual working and living conditions, he comes to understand industrial men—particularly foreigners—not as a "class" but as individual human beings, and most important of all he learns how to handle these men successfully. In getting results from Italians in an English class he follows many of the principles which are fundamental in getting results from Italians on an engineering operation. One student writes:

"My class of Italians is the finest bunch of men I've ever come in contact with—bright, keen, appreciative to an embarrassing extent. They have done me more good than I can

*Secretary, Industrial Service Movement, 124 East 28th St., New York City.

ever do them." Another says: "My club of working men was the big thing needed to complete my college education. It taught me things I could have learned in no other way, and as an engineer, I am already deriving great benefit."

So much for the philosophy of the movement. It started six years ago at Yale and has now spread to 160 colleges. During the past year, 3500 students, mostly engineers, were actually engaged in forty different lines of service for industrial men and boys every week. None of them received any pay for this work but they received a compensation far greater than any financial one—the satisfaction of service, the privilege of helping to solve some of the nation's social problems, and an experience in "human engineering" such as no college curriculum can give.

All of this work is carried on under the auspices of the Young Men's Christian Association. Students are enlisted in the work by lectures on industrial conditions and needs and the college man's responsibility, given by carefully selected employers, engineers, labor leaders and social workers.

In a three-day campaign in New York, the industrial service movement was presented to selected classes of students at Columbia, New York University and the College of the City of New York, with the result that 333 students signified their hearty interest and 170 were willing to undertake immediate work.

Recently at the University of Michigan the movement was presented to 1200 students in two days, to employers of the city at a luncheon, to labor leaders at a dinner in the city Y. M. C. A., and to a special meeting of engineering professors. At Cornell University over 1600 students were addressed, and 525 signed up as interested and willing to promote the ideas and ideals of the movement. One hundred and thirty men volunteered for definite service, and many are already teaching in the homes of foreigners, leading boys' clubs, and doing other similar work.

In practically every college the faculty heartily supports the scheme, and the sentiment of many professors was expressed when one said, "I hope every one of my students will make a place in his program for some volunteer altruistic service. They will have opportunity to do a great deal of good, but will gain far more than they can give." Recently at the University of Iowa the movement was presented to a faculty meeting which had not been addressed by any outsider for nineteen years. A number of college faculties have met to discuss the movement, and to consider the re-adaptation of engineering courses to give more attention to the "human side of the engineering profession." Already many engineering schools have courses in "management," but professors feel increasingly that even these courses have too much of the "material" and not enough of the "human element." Such instruction supplemented by personal friendly contact in service for industrial workers will do much to remove prejudices and promote mutual understanding between college men and workingmen.

That American working men are open to friendliness of this kind is splendidly illustrated by an experience with a large labor union. When the students first spoke to the members of the union, the men naturally wondered and were suspicious of an ulterior motive. But when the students went down to the union rooms two nights a week, often at considerable sacrifice, and taught mathematics and electricity, the men warmed up. As the students proved that they were not "snobs" but good fellows, the men unhesitatingly showed their appreciation. The work was so successful that it has been carried on for several years. The president of the union testifies that the wages of some of his men have been raised from $18 to $28 a week, as a result of the instruction given. A series of lectures have been given before 500 men in the union and the men have now asked the students to plan the entertainments for their social meetings. This latter request is particularly significant, as the class of entertainment formerly enjoyed was of very low grade. The work is spreading to unions in many other cities, and the students are getting an entirely different view of the rights of the workingman. In a number of instances the labor union, sometimes the Central Labor Union, has invited selected students to act as fraternal delegates, with full power to discuss and to introduce motions.

It is significant that employers and sane labor leaders alike support this movement.

As already indicated, after students have had a real service experience, their changed attitude toward the world's needs and their sense of responsibility is bound to lead to greater activity in their larger spheres of influence after graduation.

Here is what some of them write from various parts of the country:

As a student I got interested in industrial service and resolved that any men whom I might later control should get a square deal. I've just investigated the living conditions of the men in this lumber camp, and found them sleeping on old vermin-producing wooden bunks, that hadn't been changed in six years. I have had the whole outfit burned up and an iron cot put in for every man in camp.

We have put in a fine welfare club for our men, with reading, writing and smoking rooms. No gambling or liquor allowed. It certainly pays and I am delighted with my share in it.

As foreman in the steel mill, I see that my men get a square deal on the job, a better job if they deserve it, and I have taken pains to render personal service to many. We must get rid of the seven-day, twelve-hour labor schedule before we can have real men with real homes.

I have signed up 800 working men for a Y. M. C. A. membership in our mining town. After a thorough investigation, we feel that the association will meet the needs of the men better than any other agency.

Remembering what I learned in this movement at Yale, when I became foreman I treated my gang of Italians as men and not as dogs, and it was really pitiful to see the way they returned the little kindness I showed them. Each day I was met with cheery words of greeting. When the job was complete the men came to me in a bunch, thanked me for the fair way I had treated them, and said they would like to work for me always.

Thus, quietly but rapidly, without undue advertising has been advancing a great movement, reaching to the very heart of many vital industrial problems of the day. At a conservative estimate 3500 undergraduates are reaching over 60,000 working men and boys each week in definite constructive service, which will make for better understanding, the improvement of industrial and social conditions and the transforming of individual lives. No one can measure the helpful service of the 3000 graduates who also are promoting the ideals of the movement. As hundreds of engineering students continue to graduate from college with a new vision of their service—opportunities and a sympathetic knowledge of how to handle workingmen, will they not in a very real way be helping to solve the vital problem of human engineering?

# The Mississippi Lock at Keokuk

*SYNOPSIS—In the development of water power from the Mississippi River by means of the great dam at Keokuk, Iowa, one of the specially interesting features of the work is the lock which has been provided to enable river traffic to pass the dam. This lock is notable for its size (400x110 ft.), its single lift of 30 to 40 ft., and its gate equipment. The lower gates are of the mitering type, very similar to those on the Panama Canal locks. The upper gates are of a floating type never before used, consisting essentially of tanks (moving in guides) which are raised (to close the lock) by means of compressed air and are sunk (to open the lock) by their own weight.*

shops. These works have been designed and [illegible] by the company at its own expense, the plans being [illegible]oved by the U. S. Engineers. On completion they [illegible] be turned over to the government, which will own, [illegible]erate and maintain them. The company will also [illegible]ish (without charge) sufficient power for operating the lock, gates and repair shop plant.

The dam proper (which was described in ENGINEERING NEWS, Sept. 28, 1911) is 4650 ft. long, with a spillway length of 4278 ft. It extends from the Illinois shore to the upper end of a power house 133 ft. wide, which extends 1700 ft. downstream from the dam and

FIG. 1. GENERAL VIEW OF THE LOCK AND DRY DOCK AT THE WATER-POWER DAM IN THE MISSISSIPPI RIVER AT KEOKUK, IOWA

(At the left is the substructure of the lower end of the power house, separating the forebay from the river, and having an end wall connecting with the head of the lock. The dry dock occupies the space shown in the view as occupied by a shop building with smokestacks, and its gate is directly behind the stiff-leg derrick at the right. This view shows the conditions on Apr. 30, 1913. The steel traveler is one of those used in the construction of the power house, and has now been removed.)

The construction of the water-power dam of the Mississippi River Power Co. across the Mississippi River at Keokuk, Iowa, involved the complete submersion of the canal and three locks which formerly enabled vessels to pass the Des Moines Rapids at this point in the river. It was necessary, therefore, to provide new facilities for river navigation.

The old canal was about eight miles long, with its lower end and lock at Keokuk, and was formed by an embankment separating it from the river channel. Its three locks were 225x78½ ft., with a depth of 6 ft. on the sill and a lift of 8 ft. each. These works were completed in 1877, and were owned and operated by the U. S. Government, being under the control of the War Department, through the U. S. Engineer Corps. At the middle lock there were machine shops, a dry dock and other facilities for repair work on the floating equipment of the U. S. Engineer Corps.

In granting permission for the construction of the dam, the War Department required the construction not only of a ship lock, but also of a dry dock and repair parallel with the Iowa shore. The space beyond the power house forms the forebay, which is about 2450x800 ft., between the lock, the ice fender, the power house and the Iowa shore. At the lower end of this are the lock and dry dock, with concrete walls running to the shore and to the end of the power house. The arrangement is shown in Figs. 1 and 2.

Fig. 1 gives a good idea of the general arrangement, although it represents the work as it stood in April, 1913. At the left is the substructure for the lower end of the power house, with the forebay at the right. From its lower end extends a wall to the head of the lock, and in this wall may be seen the ice chute (in the left corner) and the two intakes for the power plant of the lock. In the face of the head wall of the lock are the four intakes of the culvert for filling the lock. The floating guard gate is shown in place, and beyond it (to the right) the floating gate of the dry dock. In the wall beyond this latter gate are the two intakes of the culvert for filling the dock. The building shown on the site of the dry dock (directly behind the gate) has been removed,

the lower end wall extended, and the fill at the right widened to reach the line of the dock and form the site for the repair shops. Below the lock are the drill boats for clearing a channel to the drawspan of the bridge.

The power plant is designed for an ultimate development of 300,000 hp. and consists of vertical-shaft turbines and generators forming units of 10,000 hp. each. At present there are ten of these units in operation. This plant will be described in a separate article. Transmission lines will convey current at 110,000 volts to St. Louis (137 miles) and other points, and contracts have been made to deliver 60,000 hp. to a central-station electric light and power company in St. Louis.

A railway track extends across the lower end of the forebay, crossing the floating gates of the lock and drydock. This is laid with 80-lb. rails, which on the lock walls are bolted to the top flanges of 12-in. I-beams embedded in the concrete. This track provides for handling material to and from the power plant.

All construction was done by company force, except that the steel gates (miter and floating) were built by the Chicago Bridge & Iron Works. Hugh L. Cooper is Chief Engineer of the Mississippi River Power Co., with B. H. Parsons as Mechanical Engineer.

## The Ship Lock

The lock at Keokuk is of unusual size for river navigation, the lock chamber being 400 ft. long between the gates and 110 ft. wide, with a depth of 52.35 ft. from the top of the wall to the floor (Fig. 2). The depth of water over the sill at the upper gates is 8 ft. and 14 ft., at high and low water, respectively; at the lower gates, the corresponding depth is 7 ft. and 27.35 ft. The lift is about 20 ft. at high water and 35 ft. at low water, with a maximum of 40 ft. when low water below the dam is combined with high water above it. The total water content of the lock when full is about 2,200,000 cu.ft.

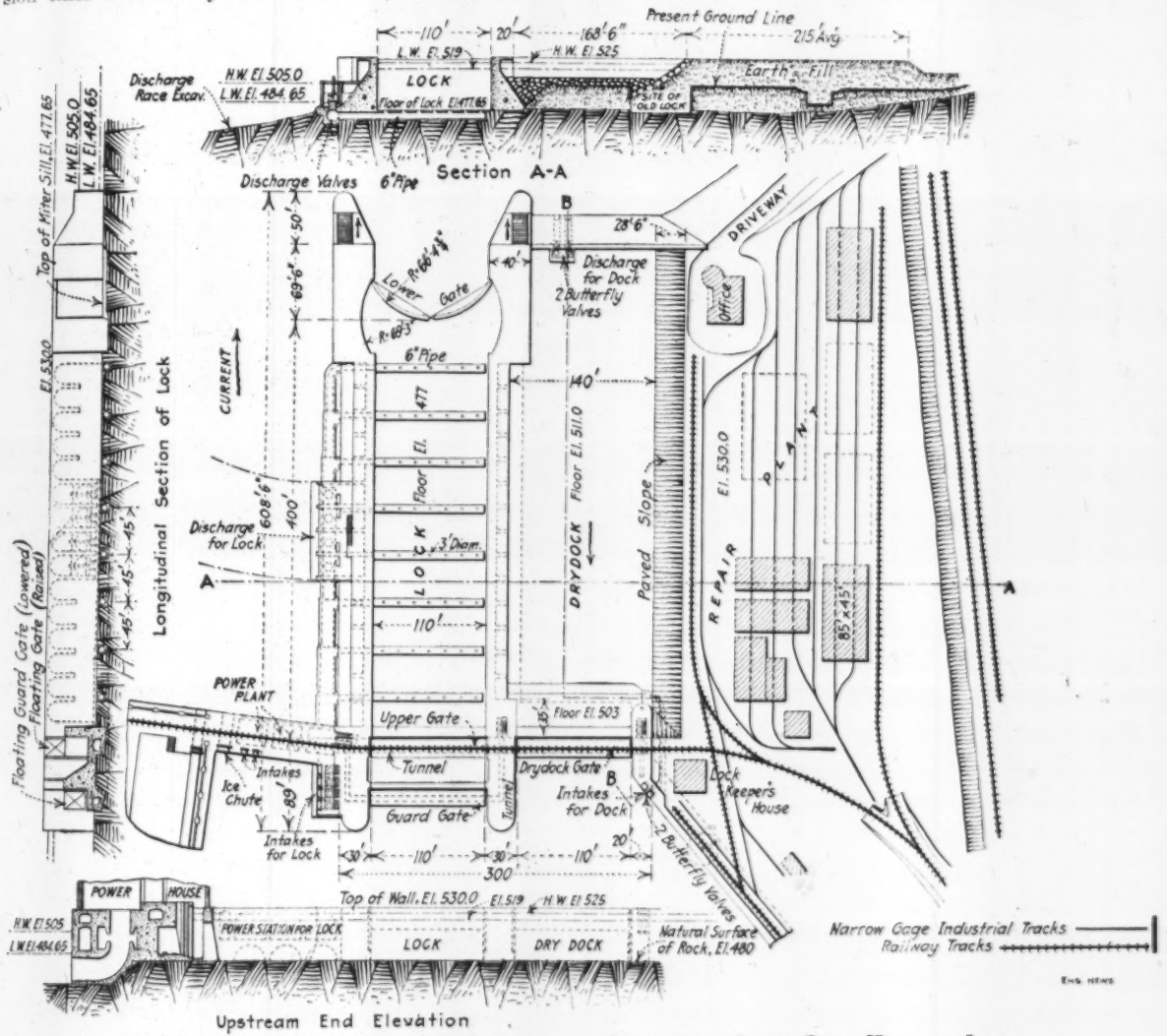



FIG. 2. PLAN OF LOCK AND DRY DOCK AT THE MISSISSIPPI RIVER DAM, KEOKUK, IOWA

To build the lock, the area to be occupied was inclosed by a crib coffer-dam, the inclosed space being then pumped out. The rock excavated was sent to the crusher plant and used for making the concrete. The bottom is in solid rock and no concrete floor is required. The two side walls are monolithic masses of concrete 608 ft. in length, with a base width of 33 ft. and a height of nearly 60 ft. above foundation. Along the lock chamber, the outside of the wall batters to a top width of 8 ft., but has formed upon it a series of arches which carry a top floor or deck 20 ft. wide, as shown in Fig. 3. At the ends, the

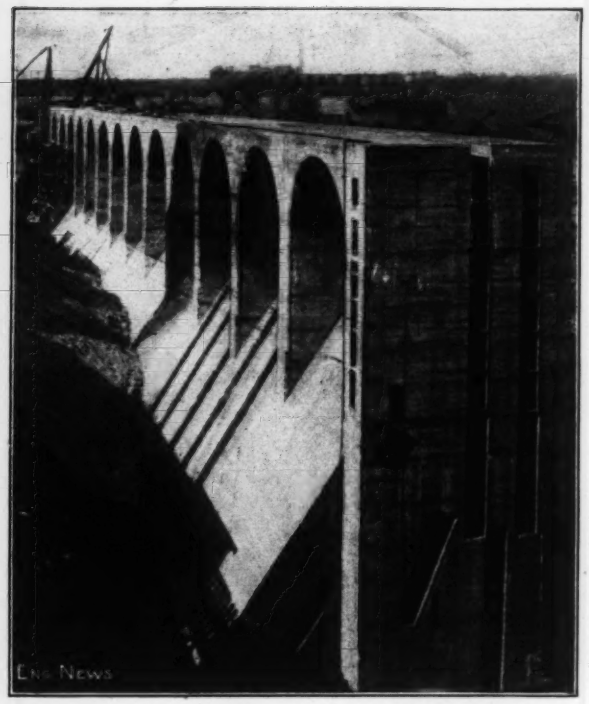



FIG. 3. PART OF REAR OF EAST WALL OF THE LOCK, LOOKING NORTH (June 6, 1912)

(The lock excavation is at the right. The space at the left now forms the dry dock.)

sides of the walls are vertical, giving a thickness of 30 ft. at the upper end and 40 ft. at the lower end, where the thrust of the miter gates has to be resisted. Each wall ends in a rounded bull-nose, on which are mounted the lamps for governing navigation at night.

The miter sill for the lower gates is a heavy mass of concrete extending across the floor of the lock. It is 9 ft. wide and 5 to 7 ft. deep, as shown in Fig. 4. At its deeper part (along the face) it is anchored to the rock by 2-in. bolts 15 ft. long, spaced 4 ft. apart. The lower 8 ft. is set in a 4-in. hole in the rock, this part being formed with barbs 1 in. long and ⅜ in. deep, and having the end split and expanded by a wedge. When the bolt was in place, and driven home to expand the end, the hole was filled with cement grout forced in by compressed air of 100-lb. pressure on the grout box, with a pressure of not less than 50 lb. at the hole.

The upper part of the bolt, passing through the 7-ft. block of concrete, is within a 2½-in. pipe sleeve. This was grouted while the bolt was under a tension of about 15,000 lb., applied by a pull of 150 lb. on a 42-in. wrench fitted to the nut. The nut lies in a recess in the top of the sill, which was filled in when the nut had been tightened and the pipe grouted.

Tests were made on experimental anchor bolts grouted into the rock as described above. The head of the bolt (below the nut) was clamped between two plates, bolted together and resting on washers on the nuts of an inverted 2-in. U-bolt. This bolt was hung upon a pin resting across a pair of 12-in. channels about 4 ft. long. One end of this beam rested on a pin on blocking (24 in. from center of bolt) and the other rested on the ram of an hydraulic jack (12 in. from center of bolt). These bolts broke at a pull of about 65,000 lb.

The concrete sill is faced with a 12x12-in. oak sill, against which bear the cast-steel contact frames on the bottom of the gates. This oak sill is in 12-ft. segments. Each segment is held by three horizontal bolts with an anchor plate ⅜x3 in., 7 ft. 8 in. long, and by four vertical bolts which have their ends expanded and are grouted into holes in the concrete.

The upper sill is a double wall of concrete, as shown by the section in Fig. 5, the unusual feature of the lock being that its floor is level with the pool above it. This wall is about 30 ft. high above the floor. The main floating gate moves in the chamber between the two parts of the wall, while the floating guard gate moves against the outer face of the upper part of the wall. This construction is shown in connection with the description of the floating lock gates.

The lock can be filled in about 10 min., and emptied in about 12 min. The average time for passing a vessel through the lock is about 14½ min., from the time of starting to close the rear gate until the head is open to allow the vessel to pass out.

The lock was opened for navigation on June 9, 1913. Previous to that time the old canal and lock had remained in use, outside of the coffer-dam which inclosed the work on the new lock. The old lock is now partly covered by the fill for the floor of the new dry-dock.

The bed of the river is being excavated below the lock gates to give a clear depth of 7 ft. of water (at low-water level) to the main navigable channel of the river, which passes through the swing span of a bridge just below the locks. This submarine work is being done by drill boats and dredges, the latter loading the masses of rock upon

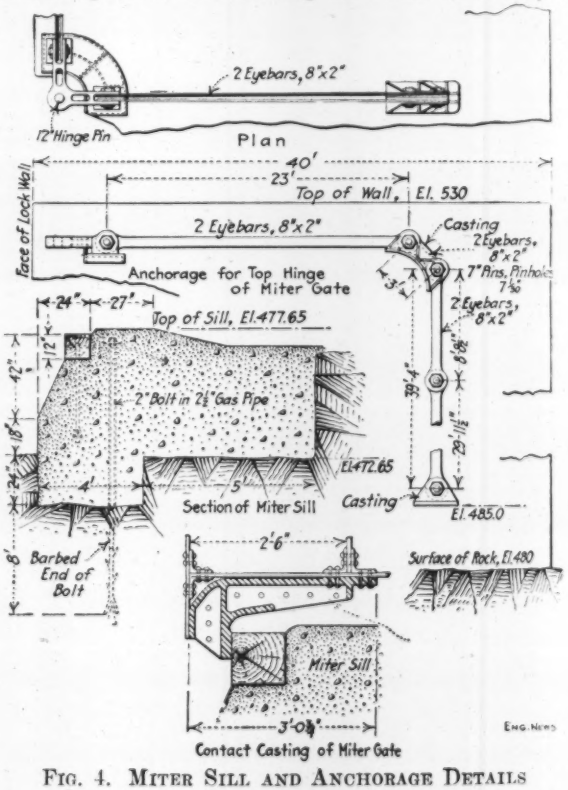



FIG. 4. MITER SILL AND ANCHORAGE DETAILS

flat boats or scows. In case it should be necessary at any time to repair the lower gates, provision is made to prevent water from backing up into the lock. This consists in installing a collapsible coffer-dam.

### Filling and Emptying the Lock

The filling of the lock is effected by a set of four intake valves at the upper end, admitting water from intake chambers in the forebay wall to a culvert under the toe of the river wall of the lock, and extending the full length of the lock chamber. The intakes have screens formed of vertical bars 3x½ in., 3 in. apart. This main culvert decreases in diameter from 13 ft. at the upper end to 6 ft. at the lower end. From it there branch eight lateral culverts, 6 ft. diameter, extending across the lock, and each closed at its farther end (Fig. 2). These branches are of steel pipe, laid in trenches cut in the lock

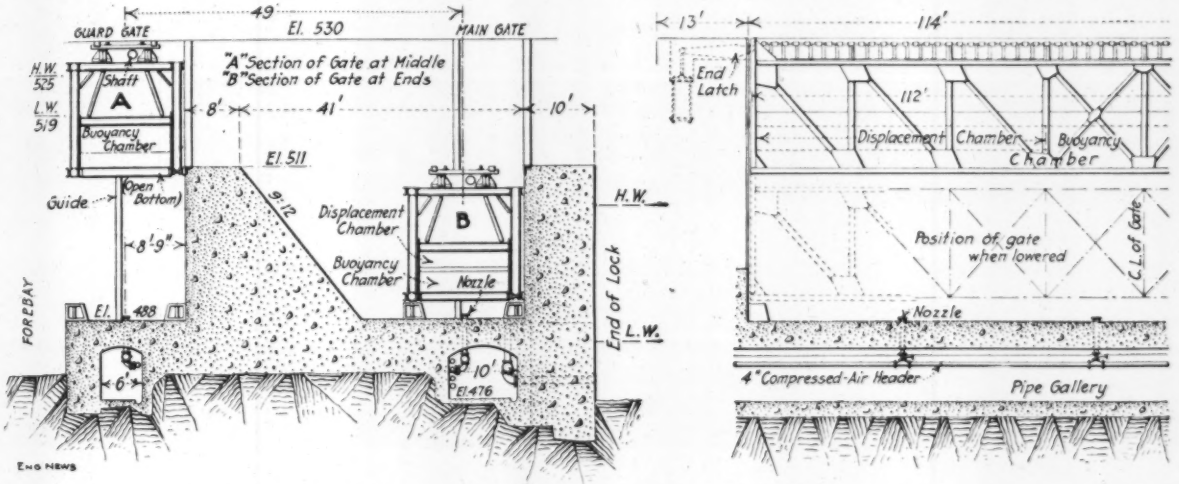



Fig. 5. Floating Gates for the Lock and Dry Dock at Keokuk, Iowa

floor and covered with concrete. Along the top of each branch are seven cast-iron nozzles 3 ft. diameter, the upper surfaces of these being flush with the floor of the lock.

In emptying the lock, the discharge is by gravity, no pumping being required. The water flows through the same conduits to four discharge valves located at mid-length of the lock wall and discharging into the river.

The four intake and four discharge valves are all of the vertical-lift cylindrical type, each operated by an inverted compressed-air cylinder, the piston rod of which is connected to the stem of the valve. Their diameter is 7 ft., and with a lift of 2 ft. 8 in. they give a clear water opening of 260 sq.ft. area. These valves are shown in Fig. 6.

To empty the lock chamber and conduit system when necessary, there is a 10-in. centrifugal pump directly connected to a vertical inverted engine, the capacity of the pump being 3000 gal. per min. This plant is placed in a chamber beside the 13-ft. conduit, near the head of the lock. For pumping drainage or seepage water from this chamber and from the tunnels for the piping, there is a 3-in. centrifugal pump with vertical shaft, driven by a 5-hp. motor. The engine of the 10-in. pump is operated by compressed air.

### Dry Dock and Repair Shops

The dry dock is a chamber about 430 ft. long and 140 ft. wide on the floor, with a depth of 19 ft. below top of wall. One side is formed by the wall of the lock, and the other is the paved slope of the fill which extends to the shore and upon which the repair shops are located. Only the upper end is open and this is fitted with a gate in an entrance 110 ft. wide. The lower end is closed by a massive concrete wall. Above the rock surface, the chamber is filled with loose rock to the floor level (Fig. 2).

Water is admitted through two butterfly valves, 6-ft. diameter, in intakes located just above the entrance. These intakes lead to a conduit 8½x6 ft., which discharges immediately below the entrance. To empty the dock, the water is discharged through two similar valves in the lower end wall, the floor having a slope of 0.5%

to facilitate drainage. Each valve is operated by a threaded stem, with a screw nut mounted on top of the wall, and with a long connecting-rod attached to one side of the rocking valve.

The ship-repair plant will include a machine and blacksmith shop, carpenter shop, saw-mill, boat house and store houses. These are served by spur tracks from the C., B. & Q. R.R. and by a system of narrow-gage industrial tracks. To operate the tools and machinery, compressed air will be furnished permanently and free of charge by the power company.

### Lock and Dock Gates

One of the most interesting features of the work from an engineering standpoint is the gate equipment. At the upper end of the lock are two floating gates, which rise and sink to close and open the lock. A third gate of the same type and size is used at the entrance to the dry-dock. At the lower end of the lock is a single pair of mitering gates, the main features of which are their height and the use of a buoyancy chamber at the bottom to relieve the weight and strain on the top hinge. The floating gates represent an entirely new type, which is applicable only under certain conditions.

### Floating Lock Gates

These gates are the most novel feature of the equip-

ment, and represent something new in lock-gate design. In brief, they are floating tanks, moving in vertical guides; and sinking below the level of the sill. This is shown in Fig. 5. To close the lock, air is admitted to

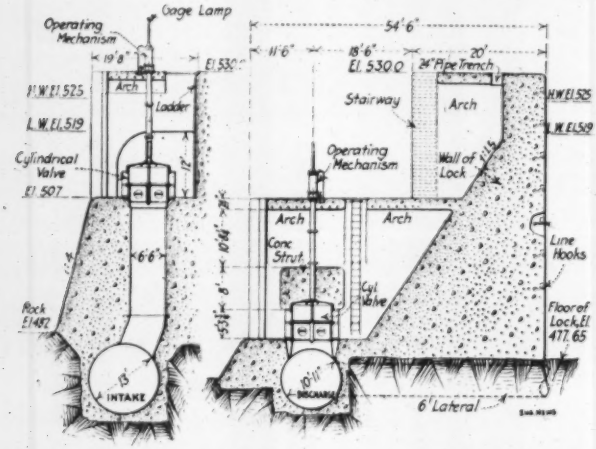



FIG. 6. CYLINDRICAL VALVES FOR THE INTAKE AND DISCHARGE CONDUITS OF THE LOCK

an open-bottom chamber in the gate to blow out the water and cause the gate to rise. To open the lock, the air is allowed to escape and the weight of the gate sinks it to its lower position. This arrangement is made practicable by the depth of the forebay beneath the sill of the lock. There are two of these gates, 40 ft. apart, the upper one being the guard gate. The dry-dock has a single gate of the same type and dimensions. Fig. 7 shows the two floating gates of the lock, and shows also the operating house. Fig. 8 shows the details of construction.

Each gate consists of two vertical trusses 112 ft. long and 16 ft. deep, spaced 15 ft. apart, and connected by a horizontal truss at the top and by lateral bracing at the bottom. The downstream truss is a plate girder, its web forming the skin plating of the gate and being reinforced heavily to resist hydrostatic pressure. The resulting pressure along the top chord of this girder is sustained and carried to the lock walls by the horizontal truss. The bottom chord and end frames of the girder are fitted with oak contact pieces, and when the gate is closed (or in its upper position) these take a bearing against cast-iron sills built into the masonry sill and walls of the lock entrance. Each gate carries a railway track, the deck being planked between and outside the rails to form a footwalk.

The flotation of the gate is controlled by two closed displacement chambers (one at each end) and one open buoyancy chamber. Each of the former is 42 ft. long, 4 ft. deep and 16 ft. wide, and their combined capacity is 4480 cu.ft. The buoyancy chamber extends between and beneath the displacement chambers, its lower portion extending the full length of the gate. It is 2½ ft. high beneath the displacement chambers and 6½ ft. high in the 28-ft. space between them. This chamber, which forms the bottom of the gate, is open at the bottom. Its capacity is 6000 cu.ft.

The gate in its lowered position rests on cast-iron pedestals on a concrete floor, the top being housed below the level of the sill (Fig. 5). Beneath the floor runs a pipe tunnel in which is a 4-in. main with four vertical 3-in. branch pipes or nozzles extending up through the floor. When air is discharged through these nozzles, it passes into the buoyancy chamber and displaces the water, which passes out beneath the gate. The displacement is under control from the operator's house. The air pressure in the buoyancy chamber is about 2.1 lb. with the gate floating, but varies from 4 to 12 lb. when operating the gates. It is 4 lb. when the gate is in the latches and with the water at elevation 522.

To insure maintaining the gate horizontal, and preventing either end from being above or below the level of the other end, there is an equalizing mechanism (Fig. 8.). This consists of a shaft extending the full length of the deck (under the track) and carrying at each end a spur wheel which engages with a vertical rack in the end guides.

The three gates are exact duplicates of each other and may be used interchangeably. The guard gate and dry-dock gate can be floated directly out of the entrances when the guides are removed. As the lock entrance is slightly narrower at the guard gate, the inner gate must be turned slightly to pass out through the entrance.

When the gate is raised, to close the lock, it is latched in position so that it has no flotation or vertical movement. For this purpose it is held at each end of each truss by a latch whose nose engages with a pocket in the end post of the truss, as shown in Fig. 9. The latch is a long horizontal casting, with its outer end sliding on a base plate in the wall, while its rear end is connected by a link to an arm on a rocking shaft, there being one shaft to the pair of latches at each end of the gate. A pair of vertical bars also forms a connection of this end of the latch bar to an anchor. To shift the latch, the shaft is rotated by a 10-in. air cylinder whose piston rod is attached to an arm on the middle of the shaft.

A similar apparatus, but with a 6-in. cylinder and smaller shaft, operates the rail-alignment device. This consists of a bar sliding horizontally against the outer

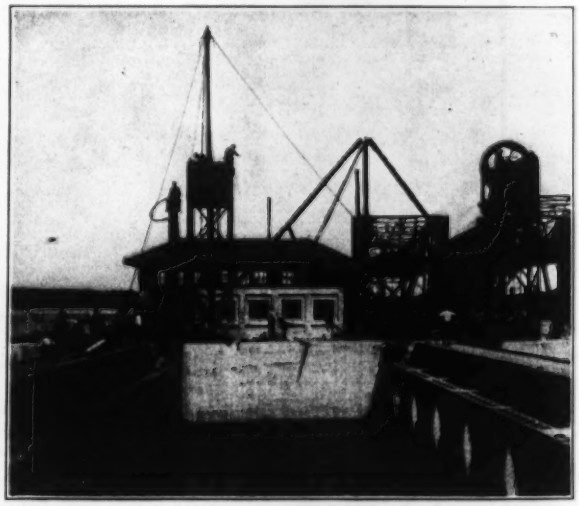


FIG. 7. FLOATING GATES OF THE KEOKUK LOCK

(At the left is the guard gate, showing its plate-girder downstream side; at the right is the main gate, showing the truss on the upper part of its upstream side. The two steel towers have wheels carrying the flexible hose connecting with the air chambers of the gates, pipes being led up through an extension end post. The man at the left is sitting on one of these posts, the top of which is level with top of dock wall when the gate is lowered. Beyond the gates is the operator's house. The steel structures in the background are the travelers used in building the power house and its substructure; they have since been removed. View taken June 10, 1913.)

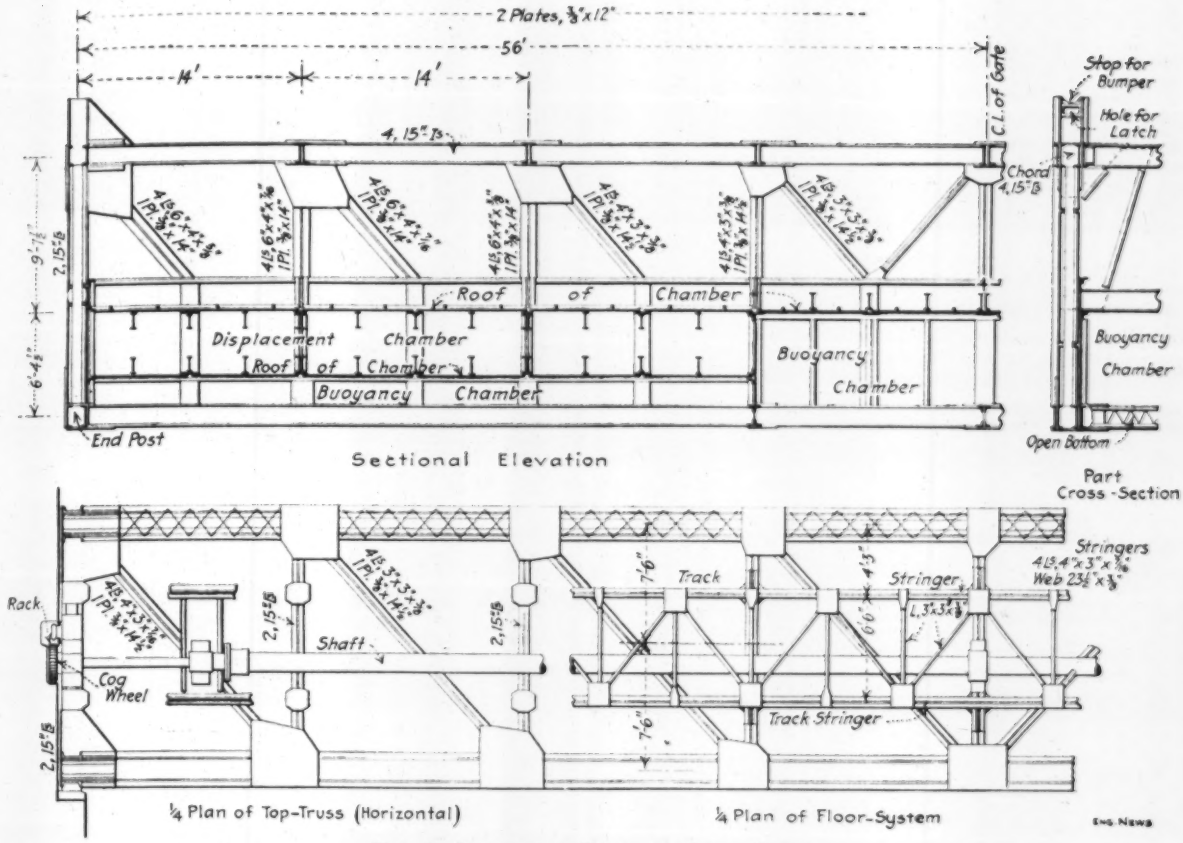



FIG. 8. DETAILS OF FLOATING LOCK GATES

side of each track rail, and extending along both the bridge and shore rails when the bridge is closed. Each bar is connected by a link to an arm on the shaft, and another arm on the end of the shaft operates a small target which shows white when the rails are aligned and locked, and red when the rail locks are withdrawn.

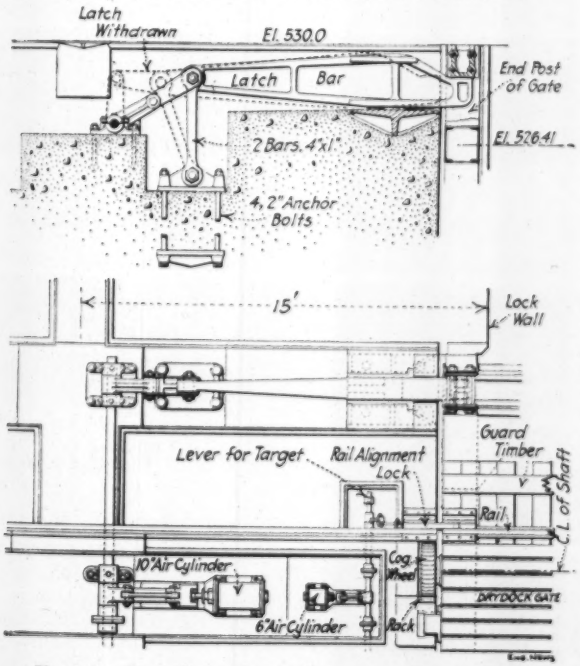



FIG. 9. END LATCH OF FLOATING LOCK GATES

To release the gate, a slight amount of air is first admitted beneath it, raising the gate clear of the latches and allowing them to be withdrawn. The vertical lift is limited to about 6 in. by bumper timbers projecting from the walls and faced with rubber on the bottom. The gate is designed to carry a 40-ton locomotive, all live-load being carried directly by the end latches.

With the gate floating and its bottom just clear of the sill, the weight of the part above water is 190 tons, while the ballast in the displacement chambers (to float the gate on an even keel) increases the weight to 210 tons. The displacement of the submerged part of the gate (excluding that of the buoyancy chamber) is 12 tons, so that the buoyant effect required is 198 tons, or 6336 cu.ft. of displacement. The volume of the two displacement chambers is 4480 cu.ft., requiring 1856 cu.ft. additional in the buoyancy chamber. This is equivalent to 4.85 ft. depth of air in this chamber, with a pressure of 2.1 lb. per sq.in. In raising the gate, the pressure in this chamber may be 12 lb. when the gate is leaving its lower seat.

In sinking the gate, the air is exhausted by a 6-in. pipe connection near the center of the top of the buoyancy chamber, this pipe being carried to one corner of the gate and up inside an end post which is extended to such a height as to be above water when the gate is lowered. To provide for the vertical movement, the end of the pipe is attached to a 6-in. flexible pipe or metallic hose which extends up a tower to an 8-ft. sheave, on a hollow shaft about 20 ft. above the lock wall (Fig. 7). The upper end of the hose is connected to this shaft, the other end of which has a 6-in. pipe to the operator's house. The

wheel and extended end-post also carry a 1-in. flexible connection for forcing air into the displacement chambers when required. Normally, however, these chambers are sealed.

The vertical movement of the gate is 19 ft., and the

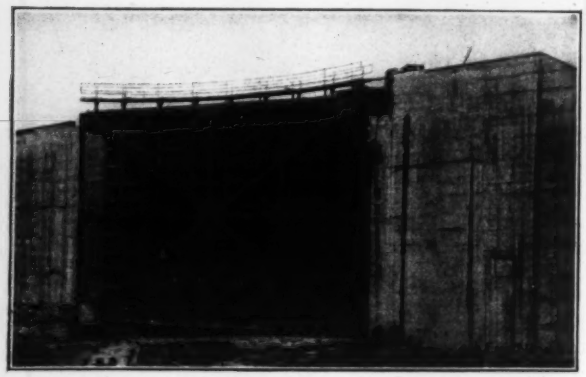


FIG. 10. STEEL MITER GATE FOR LOWER END OF LOCK; 49 FT. HIGH; 66 FT. 4 IN. LONG

(The tank built into the bottom of the gate is a buoyancy chamber.)

complete operation of raising and locking (or unlocking and lowering) occupies about one minute.

### SWINGING MITER-LOCK GATES

The lower end of the lock is fitted with a pair of steel gates of the mitering type, 49 ft. high. Each gate leaf consists of 13 horizontal ribs, curved to a radius of 66 ft. 4¾ in. on the center line, and framed together at the ends by the quoin and miter posts. There are also seven lines of intermediate framing. The chord length over the posts is 66 ft. 4¾ in. and the rise of the curve is 10 ft. 8½ in. The skin plating is applied on the convex side. The curved leaf is reinforced by heavy steel framing on the concave side in such a way as to prevent warping of the leaf, especially with power applied at the top to open the gate against the maximum head of water permitted (15 in.). One of the gate leaves is shown in Fig. 10, and the construction is shown in Fig. 11.

A special feature is the use of a buoyancy chamber in each leaf, for the purpose of relieving the weight carried by the top hinge. This is a tank of about 3840 cu.ft. capacity, formed between the curve of the face and the chord line of the bracing. The total weight of each gate, in air, is about 240 tons, and the air chamber provides a buoyancy equivalent to about 120 tons.

The gate recesses in the side walls are 70 ft. long with a face radius of 69 ft. 3 in. and a depth of 13 ft., so that when open the exterior face of the gate is housed 8½ in. behind the line of the wall. The distance between the hinges of the two leaves is 115 ft., and with the gates closed they form a curve of 66 ft. 4¾ in. radius with a rise of 34 ft. 2½ in. from a line drawn between the hinges.

The lower hinge (Fig. 12) is a nickel-steel pintle with a hemispherical head of 9-in. radius fitting a bronze bushing on the bottom of the gate, the pintle and bushing being mounted in heavy castings on the lock floor and gate respectively. The upper hinge (Fig. 12) is a 12-in. pin mounted on the gate and engaging with a steel pintle casting which projects from the top of the lock wall. This pintle casting is anchored to the wall by two sets of eye-bars, one parallel to and the other at right angles to the center line of the lock. Each set consists of one pair of horizontal and one pair of vertical eye-bars 8x2 in., connected by shorter bars of the same size, all attached to a 90° corner casting. The lower ends of the vertical rods are attached to an anchor casting 28x42 in. This anchorage is shown in Fig. 4.

When the gate is closed, a steel bearing plate on the quoin post is in contact with a similar plate on the reaction casting embedded in the face of the lock wall. The thrust of the gate under pressure is taken up by this casting, and in order to give a thrust on the bearing the center of rotation of the gate is slightly eccentric to the center of radius of the bearing plates. Thus, as the gates

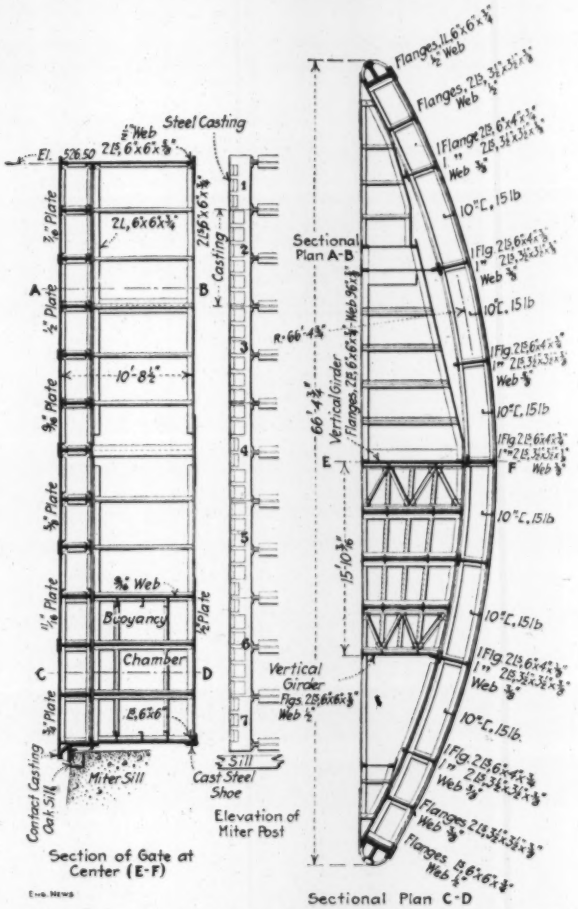



FIG. 11. STEEL MITER GATES FOR THE LOCK AT KEOKUK, IOWA

close, the plates come together with a jamming fit, which sets up an initial pressure or thrust. The bearing plates are 9 in. wide, with curved contact surfaces of 13-in. radius. In building the side walls, a deep recess was left at the position of the gate heel, and when the gates were being erected a steel post was set in position and the reaction castings bolted to it. After this was done, and the parts were adjusted to final position, the recess was filled with concrete.

The miter posts are formed of steel castings, and a recess in the face of each post is fitted with a flat steel

plate, these plates forming the joint or contact surfaces when the gates are closed. To close this joint tightly in case of some slight obstruction, there is a miter-forcing machine on the top of one gate. This is a horizontal 18-in. cylinder whose piston rod is attached to toggles

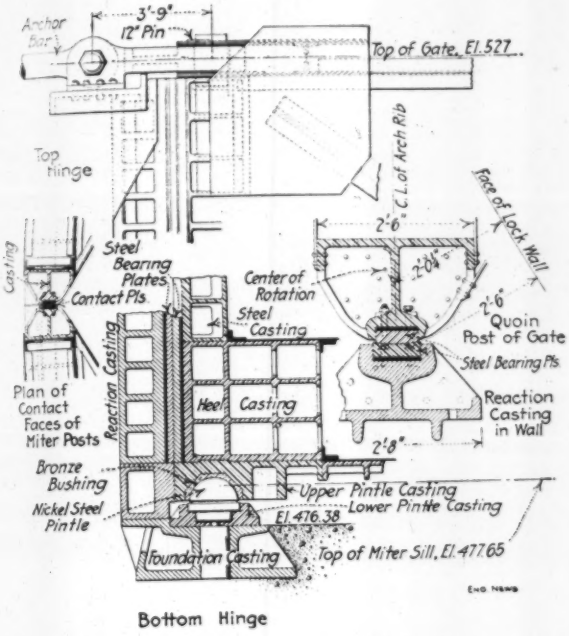



FIG. 12. DETAILS OF STEEL MITER GATES

operating a pair of hinged jaws, as shown in Fig. 13. When the machine is to be used, the jaws are closed over a 6-in. pin in the top of the opposite gate, and then closed by the toggle, thus drawing the gate posts into proper alignment.

The operating machinery is of the same type as that used for the lock gates on the Panama Canal, and is shown in Fig. 11. In a chamber at the top of the lock wall is a horizontal turntable or bull-wheel built up of structural material and carrying on the periphery a cast-steel rack of 25 ft. pitch diameter. This extends only half way around the wheel, as half a revolution effects the full movement of the gate. To the rim of the wheel is pivoted the heel of an operating strut, the strut projecting through a slot in the face of the wall and having its outer end connected to a pin in the gate.

A two-cylinder reversible engine of 40 hp. drives a shaft having a pinion ($A$) gearing with a spur wheel ($B$) on a second shaft carrying a bevel pinion ($C$). This in turn, drives a bevel spur wheel ($D$) on a vertical shaft which carries also the rack pinion ($E$) for driving the turntable. The engines run at 370 r.p.m. and are controlled from the operating house at the head of the lock. The gear ratio from the engine pinion to the turntable rack is 1:700. A double-acting compression spring on the gate end of the connecting-rod takes up shocks due either to the engine or to pressure against the gate.

To provide against damage from over-running of the engine, there is an attachment on the turntable which reverses the engine when the turntable passes 5 in. beyond its proper travel, so that if the air-supply should not be shut off the engine would simply move the gate to and fro through a small arc.

In emptying the lock, the discharge curve becomes very flat when the water has been reduced to a depth of 15 in., after which the emptying proceeds slowly. To reduce the time of locking, these gates are designed to operate against a head of 15 in. of water, thus reducing the time of locking at this end about 50%.

### POWER PLANT AND OPERATING MACHINERY

All the lock machinery, the gates and the shop equipment are operated by compressed air from a special power plant located in the end wall of the forebay. This plant consists of two 200-hp. horizontal-shaft turbines, running at 262 r.p.m., each having its shaft belted to a horizontal single-stage air compressor 13x16 in. (running

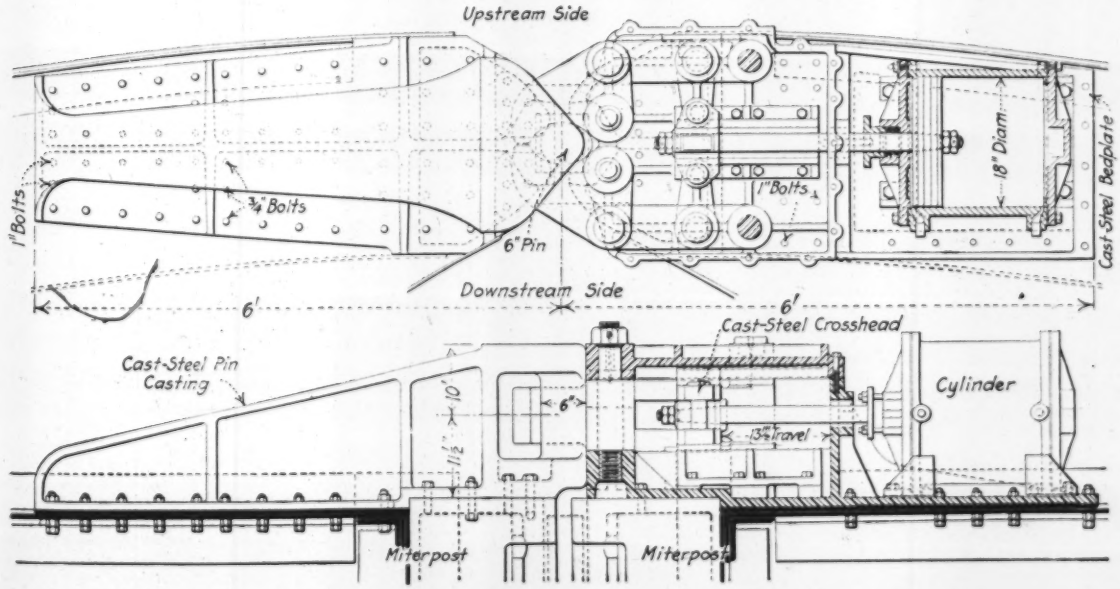



FIG. 13. MITER-FORCING MECHANISM FOR COMPLETING THE CLOSURE OF THE GATES

at 165 r.p.m.) with a capacity of 1155 cu.ft. of free air per min. The air is delivered to receivers at 100-lb. pressure. A tunnel 6x4 ft. for pipes and electric cables extends under the sill of the upper lock gate and dry-dock gate, the pipes and cables being led up through

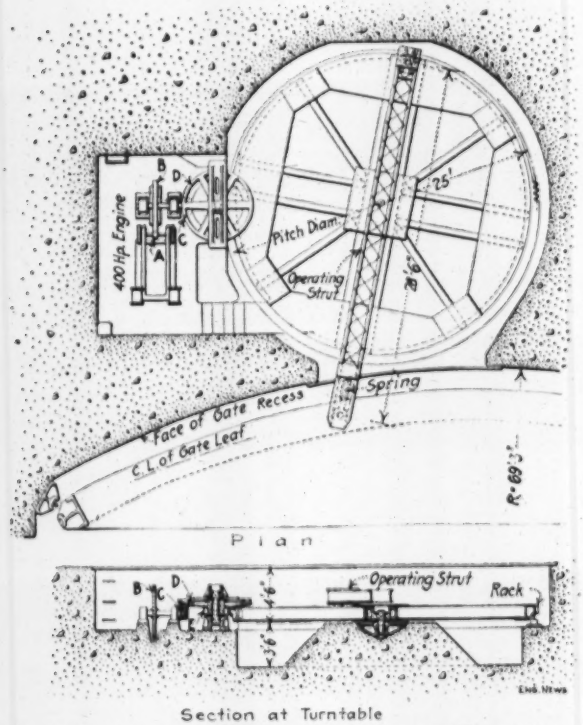



FIG. 14. OPERATING MACHINERY FOR THE MITER GATES AT THE MISSISSIPPI RIVER LOCK, KEOKUK, IOWA

shafts in the lock walls and laid in shallow conduits along the tops of these walls to the operating machinery for the gates, etc. One unit is sufficient to supply all power required for the purposes above noted. Adjacent to the power house is an ice chute for discharging ice and drift from the end of the forebay. This is 10 ft. wide, and is closed normally by a timber gate which slides in vertical guides, being lowered as required to allow water to flow over the top.

All operations of the lock valves and gates are controlled from a concrete building, not unlike a signal tower, placed on the upper wall of the lock. Here are centered the control systems of the intake and discharge valves, the pumps, and the floating and miter gates. These are interlocked to prevent conflicting movements. Electrical indicators show the positions of the valves, gates, etc., and also the positions of the turntables which operate the miter gates.

## Life of Physical Railway Property*

The basic elements which determine the life of railway physical property are: (1) use; (2) climatic and soil conditions; (3) maintenance; (4) inadequacy; (5) obsolescence; (6) the human element; (7) public demand; (8) earnings.

*Abstract of a report of the joint Committee on Life of Railway Physical Property of the American Electric Railway Engineering and Accountants' Associations (R. N. Wallis, Fitchburg & Leominster Ry., Fitchburg, Mass., and Martin Schreiber, Public Service Ry., Newark, N. J., Chairmen). Presented at the Annual Convention in Atlantic City, N. J., Oct. 16, 1913.

It is not practical or even theoretically possible to assemble compositely these several elements into any form of a logical life table that will apply equally in Maine and in California, in Minnesota as in Louisiana, or in different routes or lines of the same system embracing such physical property.

The ultimate solution of depreciation of railway property is insured earnings.

### USE

The electric railway industry came into general practical commercial life only about 20 years ago, and the principal elements of which a line is composed through various wonderful developments in the art during this period, have not been permitted to remain in use long enough, under the conditions which they were designed to meet, to determine their physical life. For instance, a track construction is designed of such section and weight of rail and joint and such depth and character of material of foundation as are ample to carry the load to be put upon it by the rolling stock which it was intended to carry. But no sooner has such construction been completed and put into use than the weight of the rolling stock and its movement over the structure are almost immediately increased to provide increased carrying capacity to take care of the ever increasing business.

Similar illustrations could be cited relative to rolling stock, generators, engines, boilers, and in fact every physical element of electric railway property. If this is a fact, how it is possible to determine in advance the ultimate life of such physical property, when its use is constantly changing from day to day, month to month and year to year?

The use of railway physical property is necessarily a purely local one with each individual property, and no two properties, even though of very similar construction and nature, would have the same amount and character of use to an extent making them comparable.

The use of one item of physical property depends greatly upon some other item to which it is closely related. For instance, the use of track depends largely upon the weight and physical condition of rolling stock, and also, to some material extent, on the character and amount of street vehicle traffic. The physical condition of track and rolling stock is also closely related to the condition of the overhead construction, motors, generating plants, etc.

Use may wear out the same items of physical property in one, five, ten, thirty, fifty years or more, depending upon the amount and character of such use, which is necessarily governed by some or all of these other basic elements. To attempt to establish the life of railway physical property based on use would result in as many different periods of life as there are properties under consideration.

### CLIMATE AND SOIL

On no two separate properties are climatic and soil conditions so similar that the physical elements of such properties would not be affected differently. A coast property would be affected by the salt water and salt air, while one inland not 50 or 100 miles away would not be subjected to such more or less destructive elements. Property in a mild climate would not be affected by the conditions met with in a cold climate. Wet and dry climates affect physical properties differently, as also do the different soils of different localities. Construction on a rock foundation has a physical life materially different from construction on any less firm foundation. Two localities may have the same soil, but one is situated topographically so that it is easily subjected to adequate drainage, while the other may be almost impossible of drainage owing to its topography. This would also affect differently the physical life of each. Any attempt to establish the life of railway physical property based on climatic and soil conditions would result in as many different periods of life as there are properties under consideration.

### MAINTENANCE

On maintenance necessarily depends the amount of use to which physical property can be subjected, and the kind of maintenance depends to a most material extent on the amount of earnings. A property maintained to a high standard of operating efficiency would naturally have longer life than a similar property maintained in a lower state of efficiency. To illustrate: A firmly constructed and adequately maintained, smooth-running track must affect more favorably the life of the rolling stock and its electrical equipment, the overhead construction, the generating plant, etc., than would a rough track less firmly constructed and less adequately maintained. A study of the maintenance costs of various street-railway properties will develop the fact that any attempt to establish a life of railway physical property based on maintenance would result in as many different periods of life as there are such properties under consideration.

### INADEQUACY

This is a subject relating to life of railway physical property that is too often confused with physical depreciation. As stated in our opening paragraph on "Use," an item of physical property may have been at the time it was installed fully adequate for the purpose for which it was designed but, owing to the wonderful strides in electric railway art and the ever increasing demands of the public, which to a large extent is responsible for the increased weights and sizes of various elements of a property, such property has become inadequate though no material apparent physical deterioration exists at the time of its inadequacy. Physical property could be adequate in one locality and inadequate in another locality though used for the same purpose.

To attempt to establish the life of railway physical property based on inadequacy would result in as many different periods of life as there are properties under consideration.

### OBSOLESCENCE

As in the case of inadequacy, obsolescence is often confused with physical depreciation. Obsolescence is also often confused with inadequacy, whereas they are not necessarily related. Physical property becomes obsolete not necessarily through depreciation of such property itself but by reason of the improvement in the art and the ever increasing demand of the too critical public, often voiced through demagogues. The end-entrance car of yesterday may be obsolete as compared with the improved side-entrance car of today, but nevertheless this end-entrance car of yesterday may be in as good physical condition as the side-entrance car of today. Numerous other illustrations could be made along this line concerning various elements of physical property to the end that any attempt to determine the life of railway physical property based on obsolescence would result in as many different periods of life as there are properties under consideration.

### HUMAN ELEMENT

This is the most variable and inconsistent element, both as relating to the public and the utility, with which we have to deal. The public of one locality may be content and satisfied with the physical railway conditions of its locality, while the public of a different locality would take an entirely different viewpoint and enforce more severe and often unjust conditions on its railway utility.

Again, those in charge of physical elements of property and the force under them in one locality may not be as efficient as those of some other similar locality; also their methods may be entirely different, occasioned possibly by the differing conditions to be met with. Any attempt to establish the life of physical property based on the human element, as found in each of such properties, would result in as many different periods of life as there are properties under consideration.

### PUBLIC DEMAND

Public demand has a material bearing on the physical life of railway property. This demand is often inconsistent, without reason and unlimited, and receives serious attention from municipal and state authorities and commissions regardless of contract agreements, rates of fare, earnings, etc. It is an ever increasing element that cannot be applied equally in one locality and in another, as such demands on different properties affect different physical items of such properties. Any attempt to establish the life of physical property, based on public demand, would result in as many different life periods as there are properties under consideration.

### EARNINGS

After devoting as much time as one will to unitizing into composite form all of the foregoing elements affecting the life of railway physical property, you come against the very essence of the whole problem, namely, earnings. A study of this subject will more than likely undo all of the so called unitizing that you may have in some theoretical manner worked out, for all of these other elements are necessarily correlated to earnings. On no two electric railway properties are the numerous conditions affecting earnings similar.

In addition to the wide difference, as between localities, of the basic elements affecting the life of railway physical property, there is also a great difference relating to franchise conditions and rates of fare which directly and unequally influence the earnings of contrasting properties.

While the engineers provide, in their yearly estimate, for certain renewals of the property in their charge, it is a fact that such property may not have been renewed at the time they provided for it to be renewed, and sometimes not for several years later, their estimate having in the interim been held up by the management for financial reasons. This same property continues to give nearly the same service at no materially increased cost of operation proportioned on the earnings it produced.

The engineers will also state that in making up their yearly estimate for renewals they do not turn to a pigeonhole in their desk and take out an "average life of railway physical property" table and reason that the table shows that an item of physical property has been in use for so many years, therefore it must be replaced. They will state that they determine these problems from an intimate knowledge of their property supplemented by a direct examination of the physical condition of the item under consideration.

Who has yet been able to define satisfactorily where maintenance ends and depreciation begins? The necessity that is vital to the electric railway of today is not some theoretical rule or theory for estimating the life of railway physical property, but rather some definite and fixed means of insuring the earnings necessary to take care of any amount of deterioration the public through its city, state and government authorities may demand. Electric properties can be maintained at any state of improvement and efficiency that the public demand and will pay for, but so long as the maximum fare is limited while this public demand is unlimited, the amount to be deducted from earnings for such purposes must necessarily rest in the judgment of those having in charge the financial management of these properties.

### CONCLUSION

This committee during the past two years has consistently endeavored to secure, from qualified representatives of member companies and others, figures expressing in years the length of life of the elements of railway physical property. Two inquiry forms have been sent out and personal solicitation for careful consideration and answers made. During the past year the form which had previously been sent out was amplified along lines suggested in the discussion at last year's joint convention.

An examination of replies received shows a wide divergence of opinion as expressed in figures among those qualified to judge by actual experience and training. Those having had practical experience for the most part felt that any attempt to express at present the life of railway property exclusively in years was at best a guess. All this goes to emphasize the conclusions of the committee that life of railway property cannot at present be expressed in any tables measuring the life either in years or units of use; that where such are attempted they are merely estimates and often no better than guesses. In the present inconclusive state of the data received, the committee does not feel justified in submitting any compilation. We suggest that the work be continued with an endeavor to establish actual life conditions in individual instances, rather than estimates.

⁂

**The Cost of a Cable-Lift Drawbridge** has been furnished us by the Pennsylvania Lines, the bridge in question being one of two parallel double-track bridges now being built across the Calumet River at South Chicago. The erection of the bridges was described in our issue of Sept. 11, 1913. The bridges are on skew, each having an extreme length (including approach spans) of about 340 ft., and a length of 210 ft. c. to c. of end pins of the lift span. The distribution of cost for one span is as follows:

| | |
|---|---|
| Substructure | $110,000 |
| Towers, including approach spans | 88,000 |
| Lift span | 70,000 |
| Electrical apparatus | 16,500 |
| Operating machinery | 45,000 |
| Rail latches | 3,000 |
| Cables | 13,000 |
| Concrete counterweights | 3,400 |
| | $348,900 |

The cost of the lift span covers furnishing and erecting the steelwork complete, the machinery and operator's houses, wood walkways and platforms and their railings. The cost for the counterweights includes furnishing and placing the concrete. The cost of dismantling the old span, providing temporary supports for tracks during erection, royalty, extras in erection, and various other items will make the total cost of each double-track bridge about $400,000. To this must be added the proportional share of the cost of the power plant, which cannot be given at this time. Waddell & Harrington, Kansas City, Mo., are the consulting engineers (and owners of the patents on the cable-lift system employed); J. C. Bland is Engineer of Bridges, Pennsylvania Lines, West.

# The Decolorization of Water by the Excess-Coagulation Method at Springfield, Mass.

Remarkable economy and efficiency in water decolorization prior to slow sand filtration has been secured at Springfield, Mass., during the past two years or so by intermittent over-dosing with sulphate of alumina. That is, during a period of 4 to 6 hr. more coagulant than is needed for either complete color removal or to use up all the alkalinity is applied to the water in a concrete conduit which discharges into a 40,000,000-gal. settling basin (a little over three days' supply). The coagulant is then shut off and the full flow of untreated water is continued. Water from this basin passes to the filters in the usual way. By this means satisfactory color reduction is effected with not over 25% of the amount of coagulant required when the sulphate of alumina is applied continuously.

A short paper on this subject by Elbert E. Lochridge, engineer of the water department of Springfield, Mass., was presented before the American Public Health Association in September, 1913 (and will be published in the *Journal* of that body). Mr. Lochridge has since rewritten the paper and added a diagram showing results in 1913. This article is based on the paper as rewritten.

The general character of the water-supply in question and the history of its treatment for color removal are given by Mr. Lochridge as follows:

> The Little River water as applied to the West Parish filters of the water-supply of Springfield, Mass., has naturally very few objectionable features. No large population is resident upon the watershed, and the sanitary conditions are excellent, so that there is no considerable danger of contamination of the supply at any time.
>
> By filtration a water free from practically all objections is produced, except that at times the remaining color is quite noticeable. The present system of coagulation is the result of a study of methods to correct this one objection to the water.
>
> This water was first used as a supply for the city in December, 1909, and in the first year or more of its use the sulphate of alumina was applied for the reduction of the color in the manner and amount usual at other plants. The chart showing the amount of coagulant used during 1910 illustrates the amount of sulphate of alumina which was necessary to reduce the color by the usual method. The application of the coagulant in 1910 and a part of 1911 was in accordance with the usual practice; that is, in amounts sufficient to secure a clear-cut reaction, and the coagulant was applied continuously. The present method is illustrated by the charts showing the amounts and the color of the raw and filtered water during the latter part of 1911 and of 1912 and thus far in 1913. As at present practiced, excellent color reduction is secured by the use of 0.2 of a grain of sulphate of alumina per gal. of water during the larger portion of the time.

Tests have shown that to secure this result the sulphate of alumina must be applied intermittently and at proper intervals. Thus, the same total amount of coagulant which gives excellent results by the method already described has no effect whatever upon the color if applied continuously through the 24 hours, or through 12 hours of the day.

Since a clear-cut reaction is necessary, tests to determine the requisite rate of application of the coagulant are made daily; or if the streams are rising and falling and changing in nature then more frequent tests are made. These tests are described by Mr. Lochridge, with comments on the reaction, and on the effect of the intermittent feed, as follows:

> From ten to twenty samples of water are taken in two-gallon bottles and placed in a row on the laboratory table. To these are added varying amounts of sulphate of alumina from a standard solution so that the effect of each amount is determined, both as to its final effect and as to the length of time necessary for reaction. For example, to the first bottle an amount which would be equal to 1 grain per gal. is added; to the second, 1.1; to the third, 1.2, etc. up to perhaps 2 or even 2.5 grains per gal. In this manner for the water of that day the amount of coagulant is determined which will quickly throw down substantially all of the color with a good precipitate in a very short time. If, for example, this reaction is found to be 1.7 grains of sulphate of alumina per gal. the feed apparatus for coagulant for the main supply is set for a feed of say 1.9 grains of sulphate of alumina per gal. This amount thus applied is always in excess of the amount necessary for the complete reaction and is also an amount which exceeds the available alkalinity of the water, so that in the prompt reaction obtained all of the alkalinity is used up and an excess of sulphate of alumina is applied to the water * * * * *
>
> It has been found that the variation in the alkalinity of the water plays but a minor part in the reaction. This alkalinity must be entirely utilized only during the period of application of the coagulant, and it has been found by experiment that changes in alkalinity have not been as important as have been the sources of the water. Very different amounts of coagulant were needed for the treatment of the water following rains, where high-level swamps have overflowed into the stream, from the amount necessary when water is drawn from the storage reservoir; and different amounts are necessary for water from the different levels in the storage reservoir and at different seasons. Different amounts have been required under different conditions or on different days on waters having indentical chemical alkalinities.
>
> The effect of the intermittent feed applied from 15 to 30% of the total time in each day is two-fold: (1) The amount of water coagulated is substantially colorless, and the mixing of this water, with a color of 0, with water of a color of say 40, represents one of the factors in the final decolorization of the water. (2) On account of the excessive amount of coagulant applied a mass reaction takes place and all of the alkalinity and coloring matter is chemically combined with the coagulant. A second reaction becomes effective at the outlet of the conduit where the water is brought into contact with the remaining uncoagulated water. This second reaction has the effect of neutralizing all of the sulphate of alumina not precipitated. Still another effect is secured which has been recognized in some plants by the introduction of hydrate of alumina to the water. The flocs thus introduced, but not formed by precipitation at that point, have a considerable effect on the improvement of the water.

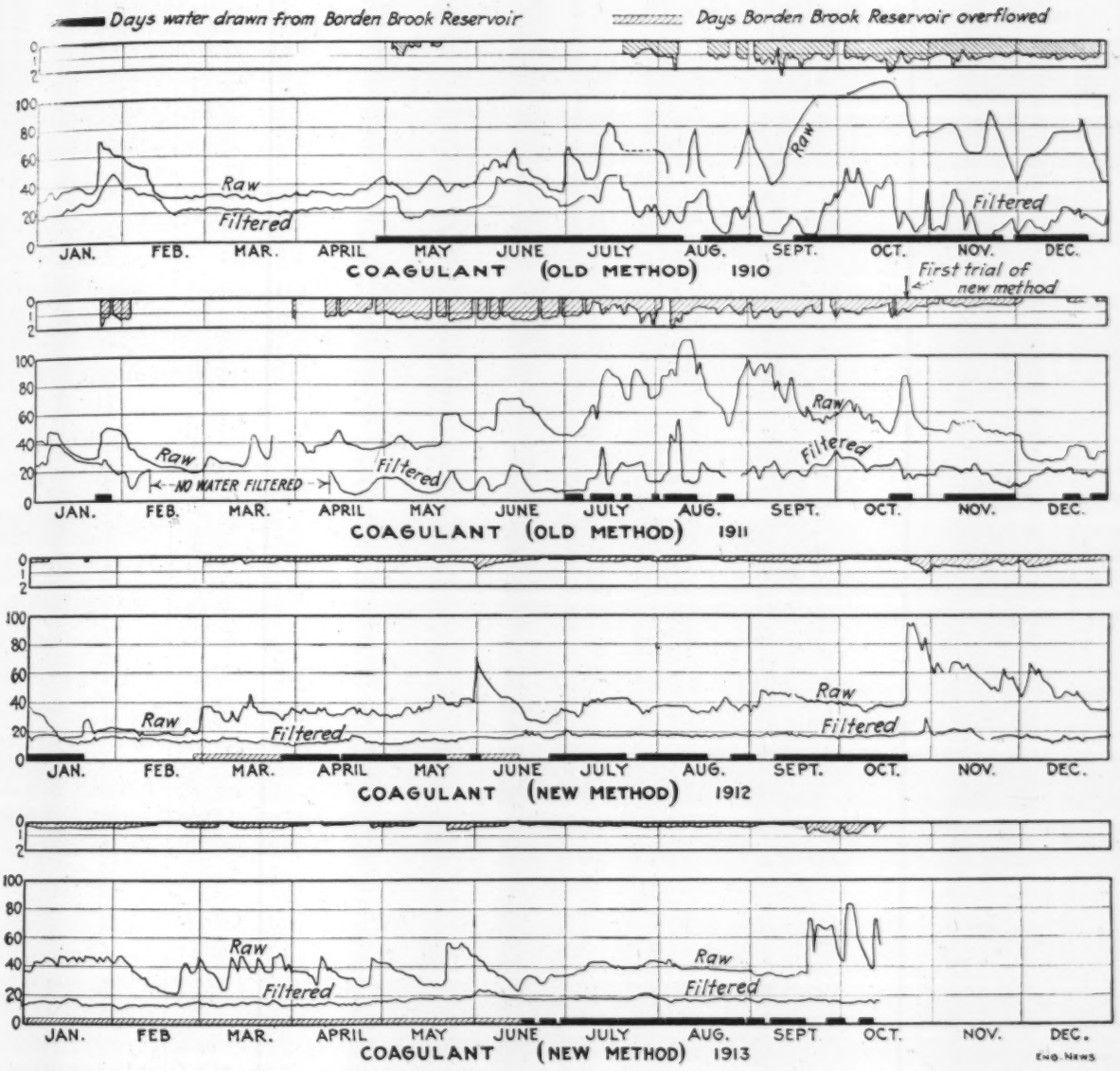
Besides the high efficiency of this method of decolorization it makes unnecessary the use of "soda ash or other chemicals for the hardening of water at any time, inasmuch as in the full reaction but small part of the alkalinity of even a very soft water is used."

The work described in the foregoing notes has been done under the direction of Herbert F. Salmonde, chemist in charge of the plant.

At our request Mr. Lochridge has added the following information regarding the significance of the Borden Brook Reservoir data shown on the diagrams:

The Little River watershed covers an area of 48 sq.mi. The only storage developed on this area is 2,500,000,000 gal. on Borden Brook from 8 sq.mi. of watershed. As this was a new reservoir in 1909, its effect on the water at the filters during the times at which it was drawn have been very marked, but in different manners during the different years. In 1910 the reservoir water was exceedingly high colored and very difficult to purify, while since that time there has been a remarkable improvement, and the reservoir water can be treated with smaller amounts than water from other sources of equal color.

The Borden Brook data were not at first recorded, but as their significance became apparent they were added to the charts. From the standpoint of operation the data


Days water drawn from Borden Brook Reservoir
Days Borden Brook Reservoir overflowed
Raw
Filtered
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
COAGULANT (OLD METHOD) 1910
First trial of new method
NO WATER FILTERED
COAGULANT (OLD METHOD) 1911
COAGULANT (NEW METHOD) 1912
COAGULANT (NEW METHOD) 1913
ENG. NEWS

DIAGRAMS SHOWING COLOR OF UNTREATED AND FILTERED WATER AND AMOUNT OF COAGULANT USED BEFORE AND AFTER ADOPTION OF EXCESS METHOD AT SPRINGFIELD, MASS.

(The color is in terms of the platinum-cobalt standard (Am. Pub. Health Assoc.) and the sulphate of alumina in grains per gallon. The heavy black lines at the base of the diagrams for each year indicate the number of days water was drawn from the Borden Brook reservoir and the corresponding hatched spaces the number of days the same reservoir overflowed. The significance of the Borden Brook data is explained at the close of the article.)

are very valuable as it will be seen that we have had the effect during almost the entire year in 1913 of the Borden Brook water, which condition would have been greatly feared at the filters in previous years.

Still added data will ultimately be obtained as to the level from which the water in the reservoir is drawn at the different seasons. This is of greater importance than any other feature in actual operation. Some of the sharp rises in color at the time the water is drawn from this reservoir and other sharp rises at the time of rains indicate how complex this situation is at first sight.

✠

**Building Concrete Bridges in Rural Kansas**—Our first bridge in Butler County was properly built, though without supervision, and our second bridge still seems all right, though workmen who were on the work insist that nothing but ½-in. rods were used where ¾-in. rods were specified, and our third bridge was properly designed but was built without supervision; and because the contractor knew that I had too much steel he only used two-sevenths as much steel as the plans called for. He also incidentally used very, very dirty creek gravel without washing, and hauled cement back to town after the job was completed, besides building the top in freezing weather. This bridge was accepted on Jan. 13, and fell down on Jan. 23. The contractor finally rebuilt it after the county paid for new steel and cement. This was a good lesson, though hard on business for a while, and we are really only just getting our people used to the idea of bridge inspection. During the past year we have built 15 concrete bridges and one stone bridge, and no steel ones, having built only one steel bridge in the last three years. Our people are moving forward along this line and I do not expect any more serious trouble about the type of bridge we will build. [Chas. W. Buskirk, County Engineer, in a paper before the Kansas Engineering Society.]

# Structural Features of a Chicago Bank Building

The construction of tall steel-frame buildings has been a feature of the development of the business section of Chicago during the past few years, these structures taking the place of older and smaller buildings. The largest of these modern "skyscraper" buildings is that of the Continental & Commercial National Bank Co., which occupies the entire block bounded by La Salle, Adams and Quincy Sts. and Fifth Ave. Quincy St. is an "alley" street dividing the regular city block, and extending only a few blocks. In plan the building is about 324x166 ft., with an interior light court 154x57 ft. This court begins at the fifth floor, the entire area beneath that level being occupied by banking rooms and offices. The exterior is mainly of grey stone.

The building is 21 stories in height, or 260 ft. from the sidewalk to the roof, and has three basement floors. Into the lowest of these latter floors (which is the boiler room, and occupies only a part of the area of the building, at the southwest corner) runs a spur from the electric narrow-gage freight railway system of the Illinois Tunnel Co., which will serve for the delivery of coal and supplies and the removal of ashes from the power plant. A freight elevator will run from this tunnel connection to the sidewalk level. In the building there will be 24 elevators: 12 will serve the first 12 floors, 11 will be express elevators serving the upper floors, and the other will be a freight elevator serving all the floors.

The main elevations above datum (or water level in the Chicago River) are as follows: basement, 2.08 ft.; first floor, 14.6 ft.; top of roof, 274 ft. The sub-basement and boiler-room floors are respectively 11.83 ft. and 25.83 ft. below datum.

The main bank rooms will be on the second floor, and the central space (corresponding to the light court above) is covered by an arched skylight roof springing from the fifth floor level. On either side of this central hall is a lofty space whose ceiling is at the fourth-floor level. At the basement level will be three large bank and safety-deposit vaults, and beneath these the earth is not excavated. The general arrangement of the lower portion of the building is shown in Fig. 1, and some features of

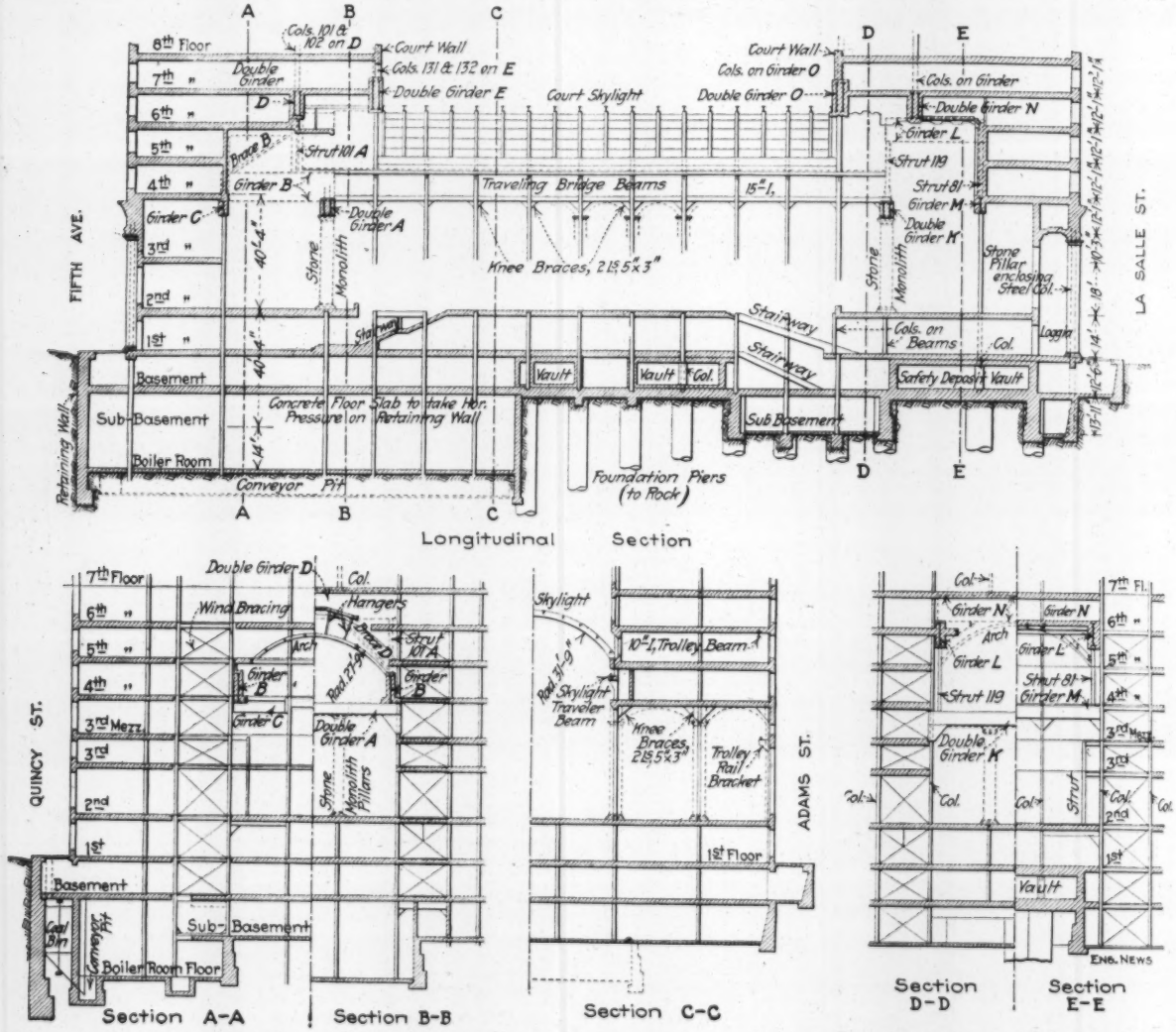



FIG. 1. LONGITUDINAL SECTION AND CROSS-SECTIONS THROUGH THE LOWER PORTION OF THE 21-STORY CONTINENTAL AND COMMERCIAL NATIONAL BANK BUILDING, CHICAGO

(D. H. Burnham & Co., Chicago, Architects. Thompson-Starrett Co., Chicago, Contractors.)

(These sections show the large open areas on the bank floor, above which are carried the upper floors.)

this part of the structure are described in more detail below.

### Foundations

The foundations are of the concrete-pier type now used almost exclusively for buildings of this class in Chicago. Spread or platform foundations upon the clay bed on which the city is built are not satisfactory for buildings of such size and weight, especially in view of the disturbance of this bed in recent years by excavations for tunnels and deep foundations. At each column location an open well or shaft in sunk, being lined with vertical tongued-and-grooved planks and interior steel ring-braces. These wells (known locally as caissons) are filled with concrete, forming foundation piers. The wells of this building are from 4½ to 10 ft. diameter, and are carried down to solid rock, which is encountered at depths of 96 ft. minimum to a maximum of 104 ft. below the sidewalk level. There are about 160 of these piers to carry the building.

### Retaining Walls

Heavy concrete retaining walls surround the basement levels, and are mainly without steel reinforcement. The main basement extends the full width between curbs, but the sub-basement extends only to the building line, and does not extend beneath the vaults, which are thus placed on solid ground. Below the level of the sub-basement floor is the boiler room, occupying an area 170x53 ft. at the southwest corner of the building, and extending to the curb lines. The sub-basement floor does not extend over this area, and the retaining wall, therefore, has an unbraced height of about 27 ft. This part of the wall is made about 38 in. thick and is reinforced by a row of vertical 20-in. I-beams embedded in the concrete. These beams are placed with their webs at right angles to the line of the wall and spaced about 25 in. apart. The arrangement is shown in Fig. 1 and in further detail in Fig. 2.

The horizontal pressure against this high wall is taken by the boiler-room floor and by a 14-in. concrete floor at the main basement level. The concrete is filled between the beams of the floor framing on that part of the basement floor which covers the deep excavation. This framing is mainly of 20-in. I-beams. The pressure is about 20,500 lb. per lin. ft. in a north-and-south direction for ten panels (about 170 ft.) along the south side of the building, and 15,700 lb. per lin. ft. in an east-and-west direction for three panels (about 53 ft.) along the west side.

The pressure is transferred into the concrete basement floor by direct contact where this floor abuts against the wall; but where it is not in contact with it (as at elevator openings, etc.) the pressure is transmitted by horizontal girders or beams (acting as wales) to struts or I-beams of the floor framing. These waling beams are usually I-beams laid flat, with the inner flange bearing against the web of a horizontal-steel channel riveted against the vertical I-beams of the wall. The concrete floor was placed as soon as the steel framing of the basement was completed.

At each of the two corners on the Fifth Ave. side a column foundation of the elevated railway had to be taken care of. At the Adams St. corner, the new foundation is formed as an enlargement of the basement retaining wall (at the curb line on Adams St.). At the Quincy St. corner, the old foundation pedestal was at the exact location of the corner of the street curb and the basement retaining wall, which wall at this point extends to a considerable depth, and is subjected to heavy pressure, as noted above. It was thought best to avoid interference with this pedestal, which was done by carrying the retaining wall diagonally inside the position of the pedestal, instead of carrying it out to the corner.

After the wall was completed, a new column was seated upon it, necessitating a slight change in the position of the girder which it supports. The wall is so heavy that no enlargement was necessary to carry the column. Midway of the curb-retaining wall on Fifth Ave., is a post supporting a stairway to the elevated station. This is supported by a pier formed as an enlargement on the inner side of this wall.

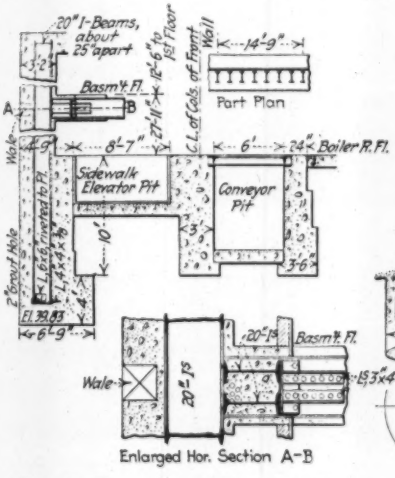



Fig. 2. Retaining Wall 54 Ft. 5 In. High, with an Unbraced Height of 28 Ft.

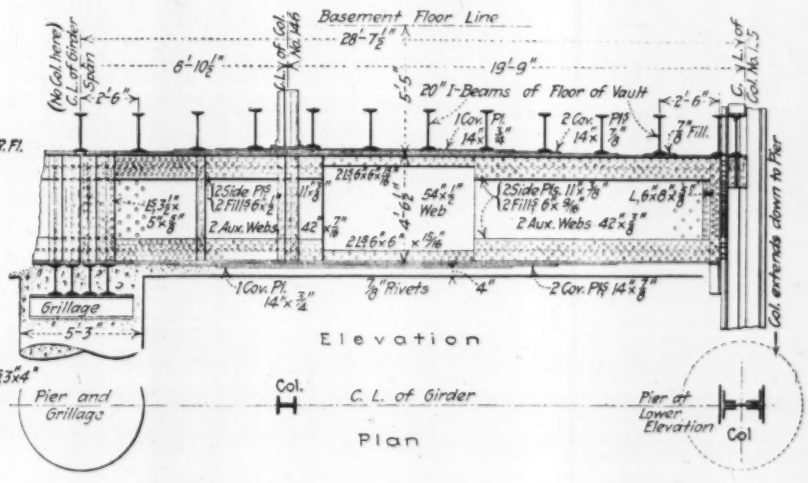



Fig. 3. Foundation Girder Supporting Intermediate Columns and the Floor of a Bank Vault

### Foundation Girders

Some of the interior columns are not carried directly upon individual piers, but upon heavy girders supported

by columns and piers. None of these girders are cantilevers, however, as in some Chicago buildings. This girder arrangement is used particularly beneath the basement level, at the location of the bank vaults; and also at about the level of the fourth floor, where the superstructure columns are seated upon girders spanning the large open spaces of the main banking floor.

Fig. 3 shows one of those girders beneath the vaults. It is 57 ft. long, with the ends framed against two main columns (extending down to foundation piers at a lower elevation), while the middle of the girder rests upon a grillage on a concrete foundation pier. Each span of the girder carries an intermediate column, and there is no column above the center pier. Some of the girders have single webs and others have double webs. Across the girders are laid lines of 20-in. I-beams, forming the floor beams of the vaults. The girder framing above the open areas of the bank floor is described below.

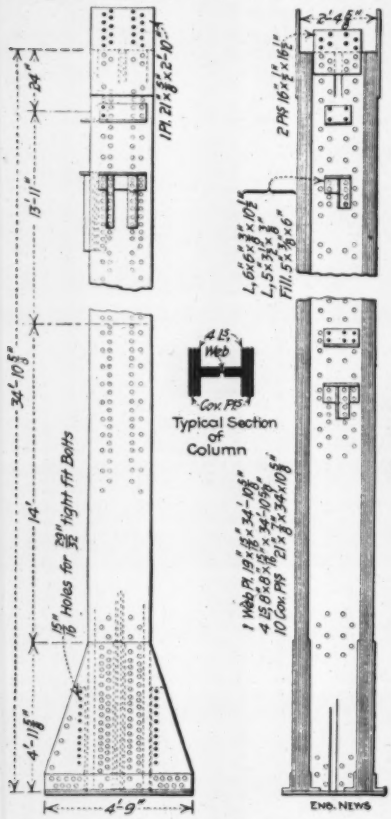



FIG. 4. HEAVY COLUMN FOR THE CONTINENTAL AND COMMERCIAL NATIONAL BANK BUILDING, CHICAGO

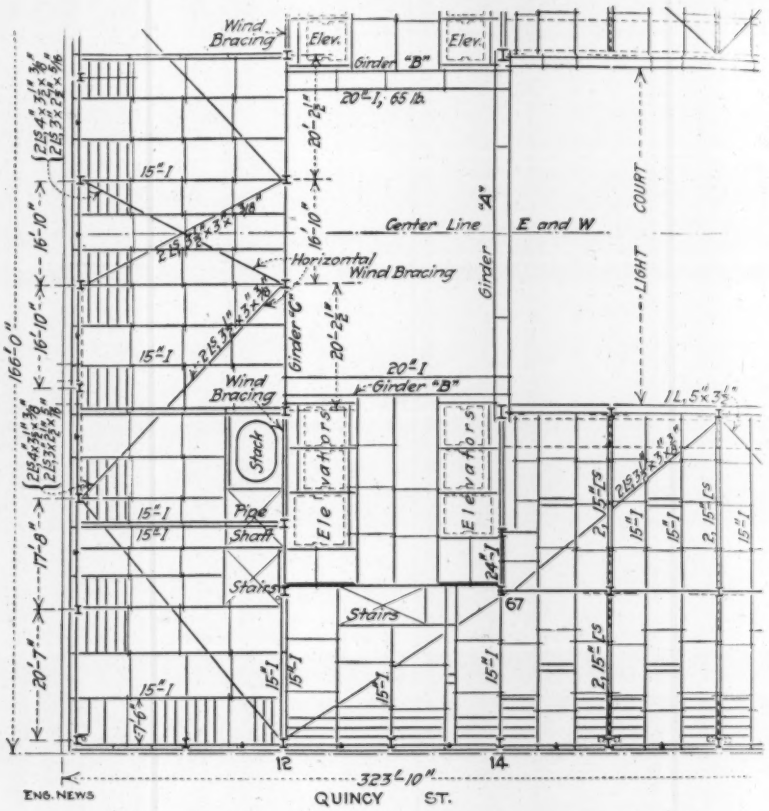



FIG. 5. PART PLAN OF FRAMING AT FOURTH FLOOR

(The fourth and sixth floors have horizontal diagonal wind bracing, as shown here.)

## COLUMNS

The column spacing is from 14 ft. to 30 ft. The columns are of H-section, composed of a web plate and four angles, together with cover plates on the two closed sides formed by the angle flanges. The lower sections of these columns are of very heavy construction, especially where there is a great unsupported length, as in the lofty banking rooms. The heaviest column is one of the interior columns (No. 103), the load on which, at the sub-basement floor, is 3,360,000 lb. The unsupported length is 18 ft., and the total length of the bottom section of the column is 34 ft. 10⅝ in. This section, shown in Fig. 4, is composed of a web plate 19x$\frac{15}{16}$ in., four angles 8x8x$\frac{15}{16}$ in., and ten cover plates 21x⅞ in., all these pieces being of the length noted.

Other columns of similar composition (but with four cover plates) are in lengths of 44 ft. 8 in. In the upper sections, the cross-sectional area is reduced, and the angles are 6x6 in. Another heavy interior column (No. 100) has a load of 3,348,000 lb. at the basement floor level, and has an unsupported length of 31 ft. 8 in. above its base.

The columns of the main front of the building, on La Salle St., are of very heavy construction, on account of their great unsupported length. One of these (No. 35) has an unsupported length of 41 ft., and carries a load of 1,525,000 lb. at the mezzanine floor above the 3rd floor. This is the load which determines the size of this particular column. In the La Salle St. front, eight of the columns are incased in granite to a height of about 41 ft., with stone capitals. These "masonry" columns form a loggia, but the stone work, of course, carries no load. The steel columns were set in place, and then rings or cylinders of polished red granite were lowered over them. As these were placed the interior space between the rings and the central steel column were filled with concrete.

The column shoes are formed mainly by gusset plates and angles, the base of the column resting directly upon the steel grillage on the pier. The grillage is composed generally of two courses of I-beams, but in some cases it consists of an upper course of 36-in. plate girders and a lower course of 20-in. I-beams.

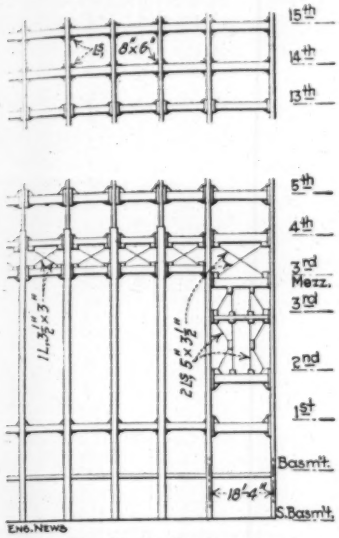



FIG. 6. PART ELEVATION OF FRAMING ON THE LA SALLE ST. FRONT, SHOWING WIND BRACING

## FRAMING

The typical floor framing arrangement is shown in Fig. 5, which shows a portion of the fourth floor. The horizontal wind bracing shown, however, is used only in the 4th and 6th floors. The panels vary from 17 ft. 8 in.x24 ft. 3⅝ in., to 17 ft. 8 in.x32 ft. In the main the framing consists of I-beams, with double channels at certain points and with plate girders or double I-beams at other points. The spandrel girders in the outer walls are mainly 24-in. I-beams, with a line of 12-in. channels on the outer side to carry the masonry sheathing and stone decorative work. The channel is reinforced by an angle along the lower edge. In the corner spans of the outer walls and the light-court walls the 24-in. spandrel beams are replaced by 28-in. plate girders, while 24-in. girders are used at certain points where suspension hangers are attached.

The floor system consists mainly of 8-, 12- and 15-in. I-beams framed between the panel and spandrel beams. In the basement floor, however, 20-in. I-beams are used almost exclusively, these being in pairs for the spandrel spans. The floors are of hollow-tile construction, except that concrete is used in that part of the basement floor which forms a horizontal girder to resist the pressure on the exterior retaining wall where this wall has a great unsupported height.

The roof is flat, except that the outer panels are inclined, forming an attic story. The roof sheathing is of tile covered with concrete and with an exterior covering of a waterproof material.

## WIND BRACING

VERTICAL WIND BRACING—The wind bracing in the two shorter sides (for both the street fronts and the court walls) consists mainly of gusset-plate connections of the spandrel beams and girders to the columns. Above the 13th floor, however, the connections are corner angles 8x6 in. On the longer east and west sides, the wind bracing consists of diagonal angles from the beams to the columns at the level of the 2d and 4th floors.

At some parts of the shorter sides, the height of the floors necessitates putting the horizontal girders at considerable distances apart, and therefore a line of diagonal or X-bracing is placed in the short panels between the mezzanine and 4th floors, immediately above the unbraced spaces. At each corner, also, there is tower bracing in the end panels, extending from the 2d to the 3d mezzanine floors. The diagonals are mainly single and double angles 3½x3 in., or 5x3 in. for the corner panels. The general arrangement of the wind bracing is shown in Fig. 6, and its details in Fig. 7.

Vertical diagonal bracing is arranged in the panel adjacent to each side of the lofty central space, this bracing extending to the 6th floor, as shown in Fig. 1.

HORIZONTAL WIND BRACING—On the 4th and 6th floors, horizontal diagonal bracing is introduced between the inner and outer lines of the main framing. This consists of single and double angles laid above the floor beams and riveted to connection plates at the columns. This is shown by the part plan of the 4th floor in Fig. 5, and in detail in Fig. 8. In most cases the gussets or connection plates are attached directly to the columns. At certain points, however, the braces cannot extend through to the columns, and are riveted, therefore, to connection plates on the 15-in. channels forming the lines of spandrel bracing at these points, as shown in the detail drawing, Fig. 8.

## INTERIOR GIRDER FRAMING

The provision of large open spaces on the lower floors, for banking purposes, necessitates special means of support for the interior columns of the superstructure above these spaces. This consists in an arrangment of massive girders which span these open spaces and upon which are seated the superstructure columns. This arrangement is shown in Fig. 1, and in more detail in Fig. 9.

At the east end, two lines of transverse girders *A* and *C*, the former of which is a double-web girder, carry struts or short columns supporting a longitudinal girder *B*. This in turn supports a double-web transverse girder *D* supporting interior columns, while the double-web spandrel girder *E* supports columns in the

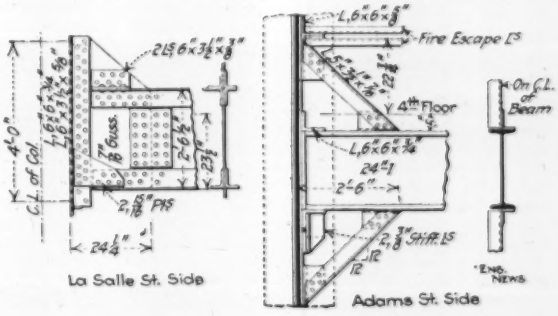



FIG. 7. DETAILS OF WIND-BRACE CONNECTIONS OF COLUMNS AND GIRDERS

light-court wall. At the west end, the arrangement is similar, except that girder *B* rests directly upon *A* and *C*, and carries struts or short columns supporting girder *D*.

Girders *A* and *C* are 48 in. deep, and the former (a double girder) has a single span of 57 ft., while the latter has three spans of about 20 ft. Girder *B* is 108 in. deep, 33 ft. 8 in. span, with a single 102-in. web at one end and two 92-in. webs (with deep reinforcing plates) extending from the opposite end to the point of

support of the intermediate column. Girder *D* is 102 in. deep, of 57-ft. span. Girder *E* is 120 in. deep, also with a span of 57 ft., and has two webs 22 in. apart.

### Arched Skylight and Skylight Traveler

Over the central part of the main banking floor is a barrel-arch skylight, having plate-girder ribs of 31-ft. 9-in. radius. The main ribs have each a 23-in. web plate, two top flange angles 8x8 in., and two bottom flange angles 3x6 in. They are seated upon longitudinal plate girders framed between the columns. The purlins are lines of T-bars 4x5 in. This construction is shown in Figs. 1 and 9.

A special feature of interest is the provision of a traveling bridge for cleaning the interior of this skylight. This has transverse girders with end wheels and supports a framework conforming to the shape of the arch. The runway girder on each side is a 15-in. I-beam having its web riveted to connection angles on brackets project-

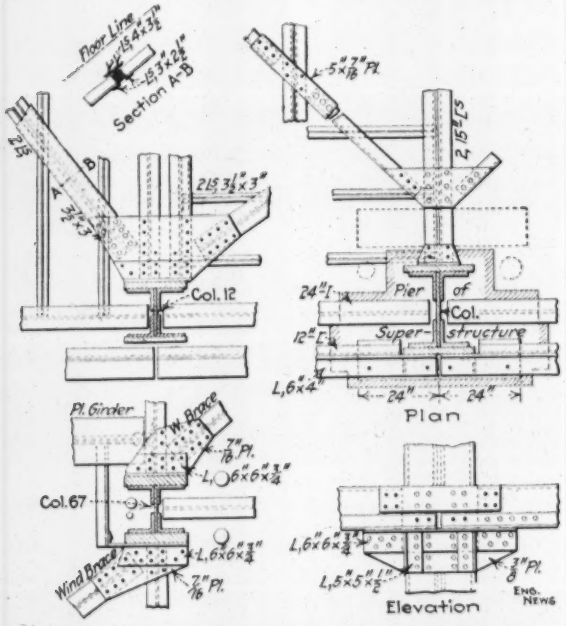



Fig. 8. End Connections of Horizontal Wind Bracing (in Fourth and Sixth Floors Only)

ing from the faces of the columns. Upon the top flange is laid the web of an inverted 12-in. channel, to which a 3-in. 30-lb. T-rail is secured by riveted clips.

At each end of the building is a pocket to receive the traveler; there being a concrete ceiling below the track to conceal the traveler from view from the floor beneath. In these pockets, the runway girder extends along the top flanges of the framing girders.

### Construction Work

The eastern half of the site was occupied by the 10-story Continental Bank Building (fronting on La Salle St.) and the 12-story Rand & McNally Building, both of these extending the full 166 ft. width between Adams and Quincy Sts. Both were steel frame buildings and were about 24 years old. The latter was notable for having its end wall carried by cantilever girders in order to avoid placing foundations on the property line.

The western half of the site was covered by old brick buildings. The wrecking of the Continental Bank Building, on La Salle St., was commenced in May, 191[illegible] and the sinking of the foundation wells was started on [illegible]y 25. The erection of the steel was commenced Oc[illegible], 1912, and completed May 10, 1913, the total amou[illegible] of structural steel being 19,000 tons. Work has been interrupted two or three times by strikes in different building trades.

The steel erection was done by means of six steel [illegible]ed derricks of 30-tons hoisting capacity. These could set the columns and framing for two floors before being raised. They had masts 100 ft. high and booms 90 ft. long, with 85 ft. as the working reach, the boom being capable of rising almost to a vertical position. The heaviest pieces handled were girders weighing 35 tons. All the derricks were operated by electric power, two having 100-hp. motors and four having 50-hp. motors. For handling the floor tile and other material there were four electric elevators, each operated by a 27-hp. motor. For placing the exterior stone work there were six derricks of 10-tons capacity with 60-ft. booms; each of these was operated by a 30-hp. steam engine.

In excavating the site and removing the spoil from the foundation wells a cable and "barney" car were used to help the loaded wagons up the plank incline to the street level. The cable was led from an electric hoist at the side of the head of the incline, and over guide pulleys, the end of the cable being attached to the car, which was a heavily loaded truck with small wheels, riding on a narrow-gage track. On the car was a frame high enough to engage the wagons. At the bottom of the incline, the car ran into a pit, below the floor level. When a loaded wagon was in place at the foot of the incline, the car was pulled up to engage the back of the wagon and push it up the incline, thus relieving the horses, and avoiding the trouble of handling snatch teams.

The clay from the wells was hoisted in buckets. The hoisting rope at each well was led over a block carried by a tripod or a four-post frame straddling the well, and wound upon a continuously running niggerhead or winch. The winches of a row of wells were driven from a hoisting engine at one end of the row by means of an endless cable, taking a turn around a grooved pulley on each winch-head shaft.

To insure satisfactory weighing of the large amount of steel removed from the old steel-frame buildings, a wagon scale was erected in Quincy St., the platform being above the street level and approached by inclines. In this street, also, was installed the concrete-mixing plant, the concrete for the foundation piers and retaining walls being distributed in narrow-gage steel dump cars pushed by hand.

The steel work was hauled from the railway to the site by wagons and lumber trucks, and the handling of the long column sections in crowded streets required skillful driving. At the site, the erection derricks unloaded the material, some of it being piled in Quincy St. and some of it on the completed floors.

The sinking of deep foundations in the clay always results in some movement in the adjacent body of clay, causing surface settlements. As the columns of the elevated railway on 5th Ave. were close to the line of excavation, it was necessary to protect the structure against settlement of its foundations. At each column heavy timber A-frames were placed under the ends of the cross-girders, the sills of the frames resting on wedges on

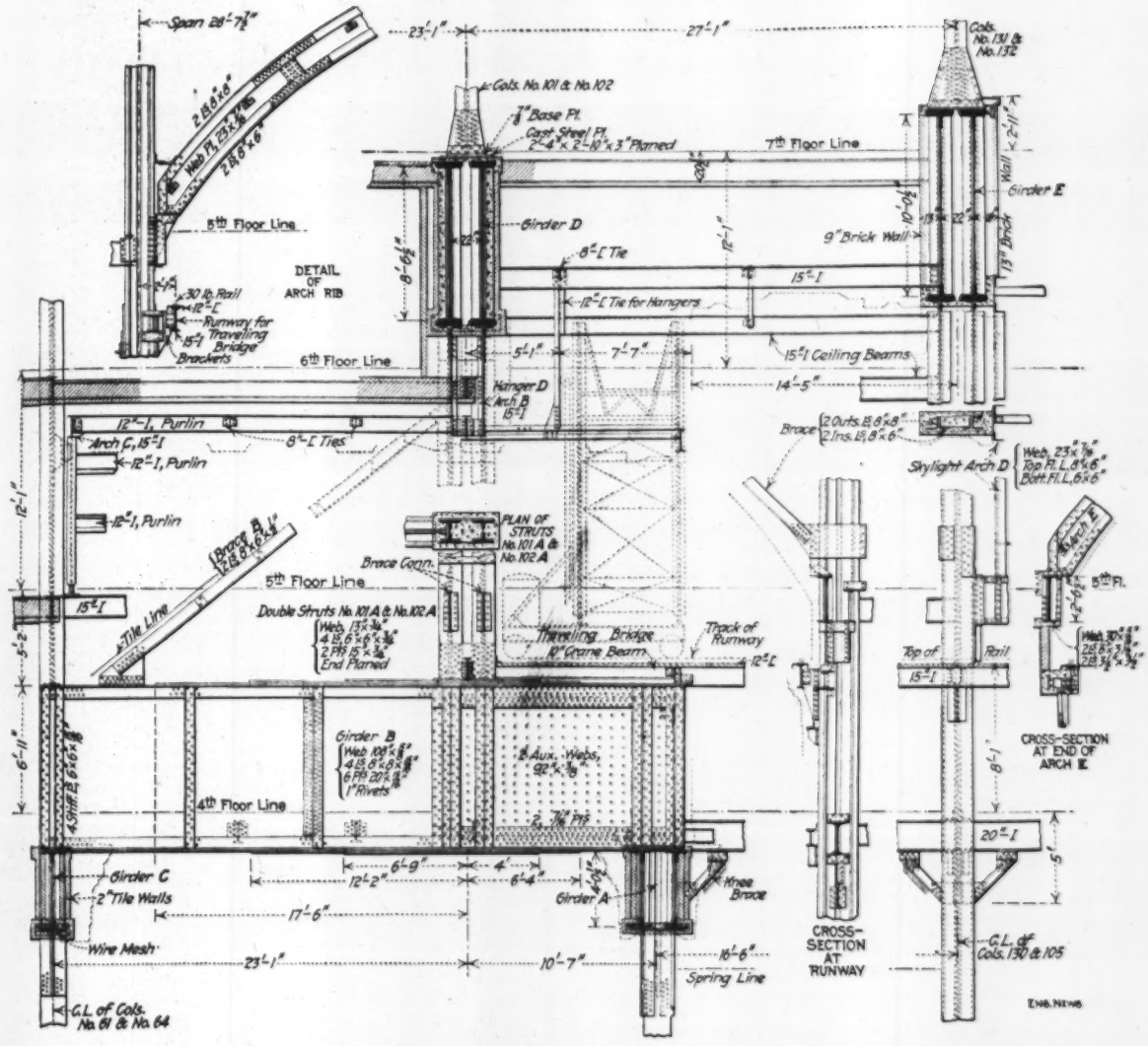



FIG. 9. HEAVY GIRDER FRAMING FOR SUPPORTING THE SUPERSTRUCTURE COLUMNS OVER THE OPEN AREAS ON THE BANK FLOOR

blocking timbers laid on the surface of the street. The blocking was adjusted by jacks as required, and the wedges provided for keeping the A-frame tight against the girder.

### ARCHITECTS AND CONTRACTORS

The architects of the Continental and Commercial National Bank Building are D. H. Burnham & Co., of Chicago. The structural design was prepared by the engineering staff of the firm, under the direction of J. G. Glaver, chief structural engineer. The Thompson-Starrett Co., of Chicago and New York, had the general contract, and the American Bridge Co. had the contract for the structural-steel work. The W. J. Newman Co. had the contract for the wrecking, the excavation work and the foundations, and the Bergendahl-Bass Engineering & Construction Co. was the contractor for the erection of the steel work.

⁂

**Municipal Contracts** with public-utility companies in Pennsylvania for light or power at fixed rates must maintain a clause that the specific stipulations shall not prevent full control of rates by the Public Service Commission, in case these are later judged unreasonable.

**A Concrete Hardening Material** now being introduced contains 95% iron dust or iron flour, which is mixed with cement for finishing the surface of concrete floors. From 15 to 25 lb. of the material is mixed with 100 lb. of the cement while dry, and one part of this mixture to two parts of sand makes the slush for the top coat, which varies from ⅛ to 1 in. in thickness. It is said to make a hard and durable floor which is waterproof and not slippery. The hardening material is used also to make new concrete adhere to old concrete in repair work. This concrete hardener is made by the Globe Steel Co., of Mansfield, O.

⁂

**Renewing Switches with Wrecking Cranes** is a method of handling track alterations that has been employed in several cases on the Philadelphia & Reading Ry. In some recent changes near Vine St., Philadelphia, it became necessary to put in some additional slip-switch crossings and to shift others, and these were handled bodily. The new double-slip crossings were put together on skids at the side of the track. Two wrecking cranes, with four-part sling chains attached to the hoisting block, were then attached to the rails and ties of an old crossing, which was ripped out bodily. Then the slings were passed two of the long end ties of a new crossing, and the crossing swung up and deposited in place, the ballast having been leveled and tamped in the meantime. The work is done very quickly and avoids the long period during which the track would be broken if the old crossover or crossing was taken apart and relaid in the ordinary manner.

# New York State Road Organization

*SYNOPSIS—A complete reorganization of the New York State Highway Department has been recommended to Commissioner Carlisle by the Board of Consulting Engineers. The State is to be divided into nine geographical divisions with a division engineer in charge of each. Each division is to be divided into approximately seven sections with an assistant engineer in charge of each reporting to the division engineers. The present patrol system of maintenance as administered has proved to be expensive and inefficient, and is to be superseded by a gang organization, each gang maintaining about 150 miles of roads. The entire cost of engineering and supervision of State highway work under this system is estimated at $884,000 per annum, based upon an annual expenditure in construction and maintenance of $13,500,000, or an average of 6½%. This organization has been adopted by Mr. Carlisle and the division engineers have already been appointed as announced in our issue of Oct. 23. The following is condensed from the report of the Board of Consulting Engineers:*

### History of the Road Movement in New York State

The first highway bills giving state aid to the localities in highway construction were adopted in 1898. There were two important laws enacted, one pertaining to main highways, known as the Higby-Armstrong Act; the other, relating to town highways, known as the Fuller-Plank Act. The first provided that the main highways of the state should be built under the direction of the State Engineer and Surveyor, and that the cost should be borne 50% by the state, 35% by the county, and 15% by the town. The initiative for all such improvement was with the locality, through the local board of supervisors by resolutions addressed to the State Engineer. If he deemed the road of sufficient public importance, he caused a survey to be made and plans, specifications and estimates to be prepared. These were submitted to the local board of supervisors, and, upon their approval, the State Engineer was authorized to award contracts therefor, when money became available by legislative act.

The first appropriation for this purpose, amounting to $50,000, was made in the spring of 1898, and was sufficient to build but five roads in various parts of the state. Under this act the following appropriations were made:

| | |
|---|---|
| 1899 | $50,000 |
| 1900 | 150,000 |
| 1901 | 420,000 |
| 1902 | 795,000 |
| 1903 | 600,000 |
| 1904 | 1,108,265 |
| 1905 | 50,000 |
| Total | $3,173,265 |

Through all these years there was continued agitation for a bond issue, because it was apparent that the annual appropriations would not be sufficient to complete a logical system within a reasonable time. In 1905, the people of the state voted favorably upon an issue of $50,000,000 of highway bonds. This issue of bonds was under a constitutional amendment which provided that the roads should be equitably apportioned among the several counties of the state.

There arose considerable discussion as to what constituted such equitable apportionment. The Legislature in 1906 provided that each county board of supervisors should submit to the State Engineer and Surveyor before Dec. 1, 1906, a scheme of highways which, in its judgment, constituted a properly connected system for each particular county. The State Engineer was empowered by this same amendment to amend, revise or approve the suggested plans of the local boards of supervisors, having in mind the proper coördination of all of these systems.

The engineer and surveyor did submit these local recommendations to the Legislature of 1907, which, with some slight amendments, enacted laws adopting the systems as recommended by the State Engineer. This act (Chapter 715 of the Laws of 1907) or so called "Map Law," was, and has been, the basis of all highway improvement under the Higby-Armstrong law.

On Jan. 1, 1909, the care of highways was vested in a State Highway Commission instead of the State Engineer and Surveyor. The Highway Commission was composed of three members, at least one being from the party which cast next to the highest number of votes at the preceding election of governor. The term of office of the Commissioners was six years, with the exception of the first Commission, the members of which were to serve two, four and six years, respectively, in order that there might be on the Commission at all times two experienced members.

The Highway Law was amended in order to permit the construction of roads in incorporated villages, and later in third-class cities, and still later in second-class cities.

There was a further amendment to create a new method of payment of the cost of construction of state highways. Heretofore, as previously stated, there was but one class of main roads, viz., state highways, which were paid for 50% by the state, 35% by the county and 15% by the town. The new classification made two separate divisions, viz., state highways and county highways. The state highways comprised 3200 miles connecting the main centers of population. These were to be paid for entirely by the state. Six hundred miles of this system had already been constructed under the previous acts.

The second-class of main roads was known as county highways. It was intended that these should be paid for as state highways had been heretofore, viz., 50% by the locality and 50% by the state. Later, however, there was a determined effort to relieve the poorer towns and counties of a portion of the expense of such county highways, and a sliding scale was therefore adopted whereby the towns paid 1% and the counties 2% for each $1000 valuation per mile. No town or county was to pay more than 15 and 35% respectively. The effect of this statute was that a varying amount was paid, being as low as 2% for towns, and 8% for counties. Broadly speaking, the state was compelled to pay about 70% instead of 50% of the cost of such county highways. It was originally intended to build 7000 miles of highway, of which the state should pay one-half, now it is intended to build 12,000 miles, one-third of which is to be entirely paid for by the state, and of the remaining two-thirds the state will be required to pay at least 70%.

In 1912 a second $50,000,000 bond issue was approved by the people. This constitutional amendment, unlike the first, provided a specific method of dividing the money among counties.

Under the 1905 bond issue the State Engineer apportioned the roads in a manner which he deemed equitable among the different counties.

The second $50,000,000 bond issue apportions $20,000,000 for state highways, and $30,000,000 for county highways, and divides these amounts among the counties as follows: One-third in proportion to the area of such counties. One-third in proportion to their population, and the remaining one-third in proportion to the total mileage of highways outside of the cities and incorporated villages.

The state system of highways comprises 3617 miles. There are completed or now under contract 1641 miles. There are yet to be completed 1976 miles. Special laws provide for 153 miles.

The county system comprises 8380 miles. The mileage completed or under contract is 2983, leaving 5397 miles to be hereafter provided for.

### Reorganization Recommended

In order to properly direct the construction of roads now under contract and to expend effectively and economically the second $50,000,000 bond issue, it will be necessary to have a highly efficient, thoroughly organized, complete and business-like Highway Department.

To meet this unquestioned need the board recommends the following plan of organization: Instead of dividing the work into departments based on theoretical functions such as planning, construction and maintenance, as at present, it divides the state geographically, and makes each Division Engineer, through the Chief Engineer, responsible to the Commissioner, at once for the planning, construction and maintenance of the roads within the territory assigned him.

A careful study of the present conditions prevailing in the Department, leads the Board to the conclusion that lack of organization, the neglect in the recognition of merit, and the failure to fix individual responsibility have resulted in a condition that is destructive to satisfactory work. The Board, therefore, respectfully offers the following plan of reorganization.

The basis of an efficient organization must rest upon the following fundamental principles:

First. Efficient administration requires that duties shall be clearly defined, carefully segregated and skillfully coördinated to cover all parts of the work without duplication.

Second. Authority must extend by definite channels from the head of the organization to the smallest unit.

Third. Responsibility must be so placed that it cannot be shifted or avoided without detection, and that if any unit fails to respect its responsibilities it will be taken up automatically and discharged under emergency conditions until routine can be reëstablished.

Faithful service must be encouraged by continuity in office.

The plan contemplates a simple division of the work of the department along strictly functional lines into three parts:

a. Highway construction, maintenance and the supervision of town highways, under the direction of the Chief Engineer.

b. Records, under the direction of the Secretary.

c. Fiscal affairs, under the direction of the Auditor.

Under the suggested plan the Commissioner shall be the administrative and executive head of the Department, and he shall have a private secretary and two or more personal advisers, subject to his call, for technical consultation and for investigation and research for the purpose of improving and developing the type of highway construction used or to be used in the state.

The Chief Engineer shall be appointed by the Commissioner and shall hold office during good behavior. His headquarters shall be in Albany and in his office shall be the deputies, special residencies and clerks to handle the office work and any technical investigations that may be necessary, including the preparation of information and statistics on road work, the conduct of tests and research work, the examination of plans, maps, designs, standards, etc., and the care of correspondence.

The actual work of constructing and maintaining roads shall be controlled by the Chief Engineer through two deputies, each in charge of a specified portion of the state, the division to be made so as to place approximately the same amount of work on each of the two deputies.

These deputies shall have their headquarters in Albany, and each should be assigned a resident engineer to take charge of affairs in his absence and in a general way to act as his private and executive secretary and chief clerk.

The state is divided into nine divisions, each in charge of a division engineer. Each division engineer shall have in his office a resident engineer competent to act in his absence and to have special charge of surveys, plans, maps, designs, estimates, payments on contracts, etc. He shall also have a chief clerk to care for correspondence, files, preparation of vouchers, etc.

The field work of each division shall be divided into approximately seven sections with an assistant engineer in charge of each. These section engineers shall report to the division engineers and shall be responsible to them.

Attached to each deputy engineer's office shall be survey parties to be assigned to the various divisions.

Under the direction of each division engineer shall be three gangs with motor trucks, each to maintain approximately 150 miles of completed state and county roads. The gangs shall be assigned by the division engineers.

The secretary shall have charge of records, reports and correspondence, as indicated on the chart. The amount of clerical assistance will vary within wide limits, depending largely upon the activity of road work.

The auditor shall have charge of all matters of accounting, disbursements of funds and verifications of vouchers. His work will also vary in volume and he shall be provided with such clerical help as is necessary.

The estimated annual cost of the organization herein outlined, including salaries, office rent, office expenses, traveling expenses, team hire, operation of motor trucks and wages of repair gangs is approximately $1,180,000 per year.

Included in this amount is $296,000, salaries and expenses of patrolmen and maintenance gangs, deducting which leaves $884,000 as the estimated expense of the administration and supervision of construction, maintenance and town highway work.

This organization and estimate is based upon an annual expenditure of $13,500,000, being an average of 6½% for engineering and supervision, a reasonable amount, and $500,000 less annually than the present expenditure for like purposes.

### Traffic Census and Statistics

Traffic census should be taken annually of each completed state and county highway and of each highway for which plans and specifications are in course of preparation.

Accurate reports should be kept of the original cost of each completed state and county highway, the annual expenditure for repairs, the cost of renewals or in the present absence of such costs an estimate of the life and of the annual amount properly chargeable to renewals and resurfacing, should be made. In short, a record of every dollar necessary to effectively and economically repair, preserve and maintain such highways. Careful computation should be made to ascertain the annual cost per ton of traffic per foot width of each of the generally accepted types of construction to determine the most economical types for the future. A record of each employee should be kept in order to determine his comparative efficiency.

### Specifications

Long trial has demonstrated that a specification, which is the description of the thing to be done by the person contracting to do it, as well as the form of the contract itself, should be brief, clear and explicit and should not be burdened with unnecessary legal verbiage, involved or obscure language. It is vain to assume that every detail can be covered in any given agreement. Good practice has, however, a recognized standard and with explicit description, which admits of no misunderstanding, with a binding contract to do the work, under sufficient bond, is on the whole more effective than an attempt to include each item involved.

### Determination of Types

The selection of the type of any given highway should be based on the trained observations and opinions of the subordinate officials, approved by the Chief Engineer. By type is meant width of highway as well as the component materials. Such width must be determined by principles involving safe travel as well as by economy in design.

The existing law provides that a locality may obtain a wider or more expensive type of construction by paying the increased cost over the plan designated by the State Highway Commissioner, but it is believed that this should be so construed that the plan of any road appropriate to the location should be determined by the Commissioner.

In the design of a road or a bridge a certain safe loading must be assumed and the road or bridge planned to carry such weight. The opinion frequently advanced that a highway or bridge should be capable of carrying an unlimited load, however applied, is unreasonable. Any such reasoning carried to a logical conclusion would result in a complete reconstruction of present highways and bridges.

It follows that wise restrictions should be established regulating the width and character of tires and limiting the maximum weight and width of vehicles using the public highways and that ample provision should be made for the stringent enforcement of such regulations.

### State and County Highways

There are at present planned about 4000 miles of state highways and 8000 miles of county highways, a total of 12,000 miles. An examination of the road map of the state indicates that many roads are unwisely included in these systems and are not of sufficient public importance to warrant large expenditures of state moneys.

Before proceeding further with such improvements, it is especially urged that a careful and impartial study and report should be made by a board chosen by the State Highway Commissioner for that purpose, to determine a proper state and county highway system, the approximate cost and a sound financial policy.

Pending the preparation of such a report, only those highways should be selected for improvement as manifestly and clearly form a part of proper state and county systems.

Assuming that the mileage remains as at present, viz., 12,000, there will remain about 7000 miles to be constructed from the proceeds of the second $50,000,000 bond issue. The average cost of improvement could not be safely estimated at less than $14,000 per mile. Seven thousand miles at $14,000 per mile aggregates $98,000,000, or say $100,000,000. Under the existing statutes, the counties contribute $14,000,000, which, with the state's $50,000,000 amounts to $64,000,000 or a shortage of $36,000,000 to complete the system as now determined.

It is probable that a careful report as recommended, of state and county systems would suggest a method of reducing the mileage to such an extent that sufficient funds would be available if county highways were paid for in the following proportions: State, 50%; county, 35%; town, 15%; and state highways, state, 35%; county, 15%, without an additional bond issue by the state.

Under present conditions and existing statutes, it is apparent that the second bond issue is insufficient; a revised plan must be at once adopted or the system will be left incomplete and disconnected.

Of the second $50,000,000 of bonds, the law requires that $20,000,000 shall be allotted to state highways, and $30,000,000 to county highways, the latter amount to be apportioned to the counties, considering their mileage, population and area. This method of division is unscientific, and can only result in confusion and disconnected roads, or unfinished systems. The counties which have an excess of funds will seek to build unimportant roads and the remaining counties will scramble for money, which existing law apportions to others. The commission, as suggested, could properly determine what should be complete systems within the present bond limits, but a constitutional amendment would be necessary to make any change effective.

### Maintenance

The so called patrol system has heretofore been adopted from the custom used on the old stone roads of France and has served fairly well in New York. It is, however, somewhat discredited now on account of the methods of construction incidental to the use of self-propelled vehicles. It is believed that where the preservation of a road does not require actual reconstruction a sectional organization should be employed under the direct supervision of the assistant engineer with sufficient number of men and proper equipment to keep in substantially perfect condition all the roads in such section.

No change in existing laws is suggested where maintenance of a road necessitates reconstruction or complete resurfacing involving a unit expenditure of over $1000 per mile. The existing patrol system should be much modified and the number of patrol men greatly reduced. Except on bituminous roads where the travel is excessive, or on old macadam or gravel roads the gang system is undoubtedly most effective and should be adopted.

The gang system of maintenance herein recommended will effect a saving over the present methods of $700,000 annually, will prolong the life of the roads and keep them in better and more serviceable condition.

Careful reports should be made stating the actual condition of each completed state and county highway, and an accurate estimate of the cost of its maintenance, repair or reconstruction. Unless the state and county highways heretofore completed are placed in a proper condition, without unnecessary delay, such enormous annual maintenance appropriations will be required as will discredit the entire road movement throughout the state.

### Town Highways

Town highways are constructed by the town superintendent of highways at the joint expense of the town and state. The amount of state aid to towns between certain limits varies from 50c. to $1 for each dollar which is raised by the town. The work is supervised by the county superintendent of highways and in a general way by the State Highway Commissioner.

### Inspection and Supervision of Town Highways

The state inspection of town highways has been carried on under a deputy with a force entirely separate and distinct from the division engineer. There are ten district supervisors who make inspections and report directly to such deputy.

The supervision of town highways and the inspection of town reports and records can be done more conveniently and satisfactorily by the assistant engineer under the direction and control of the division engineer. The control of the division engineer insures uniform practices and standard methods, coördination of town work with the state and county work. Citing a specific illustration: Bridges and culverts on town highways which are later to be improved as state or county highways would under such supervision be properly centered, at correct elevations, of sufficient waterway, adapted to and in harmony with future work and requirements.

### Bridges

A bridge is an integral part of the highway, equally as important as the roadway proper.

The existing law provides that bridges shall be built by and at the expense of the towns; the plans, specifications and estimates must be approved by the county superintendent of highways, and if the bridge is let under contract and costs in excess of $1000, the plans, specifications and estimates must also be approved by the State Highway Commissioner.

The present method of approval of bridge plans by both the state and county highway officials causes delay, is unwieldly and cumbersome without corresponding benefits. It is submitted that the bridge plans should be approved by a county or a state official and not by both, preferably by the county, because the county may share in the expense and such a course would prevent delays and permit town officials to consult with the county authorities.

In cases where the county superintendent might be able to pass upon a complicated bridge structure ut outside help, he should have the privilege and opport to be advised by the Division Engineer in charge of the ty wherein the bridge is to be built, and if the bridge a proposed or completed state or county highway, the ty superintendent should be compelled immediately u the receipt of bridge plans to report to the Division Engi the general features of such plan so that ample opportu if desired, might be given the State Highway Commiss to issue special instructions to such county superintend

### CONCLUSION

The proposed design for administration has been su ted to the best authority on economical organization in thi try; and what is presented has the full indorsement o high authority.

In studying the present conditions, the excessive co of the administrative departments has impressed itself upo the board; the number of unnecessary employees, the lack of interest, the lack of cohesion and concerted action, are very apparent.

It is manifest, therefore, that the first step to be taken must be to put into operation a plan such as the one offered in this report, but it cannot be expected that efficiency will immediately result. A new plan requires time to get into smooth running order, even with experienced men. The men themselves must be trained in the new order and the new responsibility. It will take time to replace the incompetent and to choose the efficient.

It is also undoubtedly true that the present engineering force, under proper control, with their duties and responsibilities fixed and understood, would soon develop into an efficient and capable organization.

The Board has presented a variety of specifications covering the recognized types of road, but it is nevertheless satisfied that the experience and practice of road builders in this country and other countries are leading inevitably to roads of more substantial character, even though of greater initial cost.

It is recommended that:

(a) The Highway law be amended to provide for the organization as herein described.

(b) A board be created to consider and report upon appropriate state and county road systems, and methods of financing them.

(c) Statistics be compiled, including traffic census and cost data, and continued tests be made to determine the most effective and economical forms of construction under the widely varying conditions.

(d) Complete records of all employees be kept in order that the most efficient organization can be soonest perfected.

(e) All state and county highways be sign posted.

(f) Dangerous curves on state and county highways be widened and suitably banked.

(g) Old road surfaces be utilized for foundations, as far as practicable.

(h) The greatest care be exercised in the selection of materials and by thorough workmanship to secure good construction.

(i) Construction, maintenance and town highway work be consolidated.

(j) The engineer or construction department be made permanent and kept free from politics, and be required to pass upon technical matters only.

(k) The commissioner through consulting engineers be kept fully in touch with construction work and be informed of the most advanced methods in use in other states and countries.

(l) The commissioner prescribe regulations limiting the size, width and weight of vehicles, and governing the width and character of tires.

(m) Immediate reports be made on the condition of all completed state and county highways and estimates made of the cost of reconstruction, repair and maintenance of each.

The plan of reorganization herein recommended will not only save the state more than a million dollars annually, but insure greater efficiency. It will bring about careful and accurate inspection, the lack of which has resulted in the past in road failures and consequent loss and extragavance.

Delayed and ill considered decisions in the past have resulted in grave injustice to contractors and state alike. Prompt final inspection of all contracts will prevent the former annoyances and unreasonable delays in final acceptance and payments.

Respectfully submitted,

GEORGE C. DIEHL,
HAROLD PARKER,
WILLIAM DeH. WASHINGTON.

# EDITORIALS

## Employment and Investment Combined: A Warning

Our attention has recently been called to a concern which has been advertising an offer of employment to engineers of various classes, but has made all its contracts for employment conditional upon the investment of a certain amount in the stock of the concern.

Upon its face such a proposition may at times be made to look very attractive to an engineer, especially to an engineer who has not had considerable experience in the ins and outs of business management. It sounds very plausible to say that a concern desires to operate on a coöperative plan and to have all its employees interested in its success.

If a concern has a large and well established business, not subject to fluctuations, and if it has honest and efficient management, and if the controlling stock interest is in the hands of men who propose to retain it and to see that such honest and efficient management continues—if and where all these conditions exist, there may be something to be said in favor of an engineer, having some small amount of money to invest and desiring to secure a position, accepting employment with such a concern. On the other hand, there are other things to be taken into account. If an engineering or a contracting concern is doing a large and profitable business and its owners wish to continue in it, they are generally not anxious to take all their engineering employees into partnership, particularly men whom they are just engaging and whose fitness to the particular business has yet to be demonstrated.

The employee himself, on the other hand, may find his position or his associates not to his liking after a few months and may then need the savings he has invested in the concern for other purposes.

It may in fact almost be laid down as a general rule that, considering the interests of both employer and employee, the latter should not purchase an interest in the concern, small or large, until he has held his position several months at least and knows by his personal knowledge of the business and of the people in charge of it that the investment is one that it is wise for him to make, and that those in charge of it are men with whom he will wish to be continuously associated.

On the opposite side also, no first-class concern, managed on business principles, will wish to take in an employee as a partner or part-owner until he has been with the concern long enough to have demonstrated his entire fitness for the place and to be such a man as the firm will desire to continuously retain in its employ.

For these reasons and numerous others it may be stated as a general rule that any offer of employment which is made conditional on stock ownership, should be given the most careful investigation by an engineer before acceptance; and if he has not himself sufficient business experience to trust his own judgment regarding the offer, he should seek the advice of some personal friend who has the necessary knowledge and judgment to give him reliable counsel.

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## A Power Plant Designed as a House of Cards

The wrecking of an important power plant in Utah, on Oct. 26, is described in a news note in this issue. The peculiarity of the accident merits at least passing attention, though the reports at present available are somewhat conflicting and doubtful. It would appear that the outlet casing on a new Francis turbine in the Pioneer Station of the Utah Light & Railway Co., at Ogden, had been opened up, when a motor-operated control valve opened, sending a flood under 450-ft. head into the turbine room. The valve was shut by hand, but gave way immediately, probably under the effect of water-hammer pressure. The branch-pipe control valve was next tried and it broke down in the emergency. Attempt to shut off the main penstock control at the station failed. Finally after several hours, men were able to close the head gates, but then the 6000-ft. pipe line in emptying collapsed at several points. Meantime the water rose in the station until it poured out of the upper windows, when the lower-story openings gave way and provided relief. Naturally some of the apparatus in service was short-circuited by the water and burned out. A part of one wall of the building was carried away and the immediate district sustained a miniature flood.

If the foregoing chain of events is what actually happened then it is evident that this station, either by faulty design, or gross carelessness of some operator, or by both, was rendered a literal house of cards, in which a slip of the hand was the key to all these successive destructive steps. The story has so many evidences of possibility that, even if exaggerated, it brings the same warning to designers as though every detail were correctly reported. In the first place, no employee should have attempted to open up the turbine casing with only one barrier closed between the machine and the flood, and that capable of being opened by the accidental flip of a switch. At least one of the other available valves should have been closed even if a large section of the station had to be shut down. Every valve inserted to prevent such an accident seems to have failed; in the design of the station the action of these several valves, under emergency conditions, could hardly have been properly considered or this would not have happened. The pipe line was not provided with vent openings for service in emptying. All these evidences of inadequate design, taken in connection with the carelessness of the workmen, seem to indicate that just what happened was invited.

In 1908 at the Cazadero plant of the Portland Railway, Light and Power Co., a 5000-hp. hydraulic turbine unit ran away, blew apart and wrecked the governor of its

neighbor, which did likewise. Three machines were thus wrecked and the station was nearly demolished. The fault was then traced to the failure of the designers to consider the runaway speed which the machines could develop under most unfavorable conditions at the plant, together with undue reliance on the ability of a governor to control its machine absolutely and always (see ENGINEERING NEWS, July 23, 1908). This accident made a deep impression on station and turbine designers throughout the country and was an excellent but expensive lesson on the study of emergency conditions. This last accident brings home a similar lesson. These two accidents have points of similarity where insufficient attention to details resulted in disaster. It was not right in the earlier case that the underlying fault should have been sanctioned, nor does it seem, from perhaps insufficient knowledge of the latest example, but what prevention of trouble was plainly neglected at Ogden.

## More Agitation for Federal Aid to Highway Construction

The United States Good Roads Association, which holds a convention in St. Louis this week, is an organization whose purpose is to secure Federal appropriations for highway construction. The president of the Association is Senator Bankhead, of Alabama, and he is the author of a bill introduced in the Senate on Sept. 15, appropriating $25,000,000 from the Federal treasury to aid the several States in the construction and maintenance of any roads used as a post road or rural-delivery route. The bill provides that the United States will pay half the cost of such roads and that the Federal and State authorities shall have joint supervision of the plans, construction and maintenance.

The matter of Federal aid in highway construction has been fully discussed in these columns at various times, and there is no need for repetition at this time. It does seem worth while, however, to point out the folly of providing that a great public work should be carried under a dual system of control. To set at work two separate and independent sets of engineers to make plans, specifications, let contracts and supervise construction is manifestly unwise. It is a cardinal principle of organization that responsibility should not be divided. If a road were constructed by Federal and State engineers jointly, the public would not know which engineers to blame if the road proved a failure. The opportunities for endless friction and resulting inefficiency in such an organization will be clear enough to every engineer who has held a position of authority.

The State of New York, in fact, for many years experienced the evils of division of authority in connection with its public works, which were in charge of a State Engineer and of a Superintendent of Public Works, each with his own independent organization and with no authority of the one over the other.

It may be noted here that the same inherent defect of divided authority was incorporated in the Federal aid bill drafted by Ex-Senator Bourne, of Oregon; and this defect was pointed out and roundly condemned by one of the speakers at the recent road congress in Detroit.

If the demand for Federal appropriations for road construction becomes too strong to be resisted, it is to be hoped that any such legislation may be so framed that a proper engineering organization may be provided for the conduct of the work.

## The Pennsylvania Vote on a $50,000,000 Bond Isssue for Good Roads

The fact that the public is always more interested in men than in issues and principles is well illustrated by the counting of votes in an election. Within twelve hours after the polls are closed, canvassing of the votes cast has generally been sufficient to determine in almost every case who are the successful candidates. But where the voters cast ballots also on constitutional amendments or other matters on which a popular referendum takes place, days and weeks often elapse before the final result is determined; and so little interest is felt in the result by the general public that the newspapers often fail to record the final fate of important measures.

The voters of Pennsylvania at the election on Nov. 4 balloted upon the question whether the State constitution should be so amended as to permit the issue of bonds to the amount of $50,000,000, to be applied to highway construction and improvement.

For several days the result was in doubt. The city of Philadelphia, from which returns were first received, cast a heavy majority in favor of the bond issue; but the rural districts voted solidly against it. Announcement is received by wire as we go to press that the final majority in the entire State against the proposition was 59,556.

The vote in Pennsylvania, properly understood, does not mean, we believe, that the farmer is opposed to road improvement. On the contrary he will favor a program of road improvement which provides for the reasonable and intelligent improvement of the roads which he uses in going to and from the villages where he markets his produce and buys his supplies, and which he uses also for the social purposes that make life on a farm worth the living.

But if the funds raised by taxation, or by bond issues with the credit of the State at stake, are to be used for constructing pleasure automobile roads from city to city, the farmer sees clearly enough that only a very small fraction of the agricultural area of the State will reap the slightest benefit from the expenditure.

State aid in highway construction is very commonly defended on the ground that the cities, which pay a large proportion of the State tax, ought to help to build the country roads, on whose use the prosperity of the city, which after all depends on the prosperity of the country, depends. From this point of view the farmer might be expected to enthusiastically favor State aid for road construction; and we believe he would do so if he were well assured that the money was to be expended primarily for the benefit of those to whom the use of the roads is a necessity and not for those who use the roads for sport and pleasure merely.

Considering the vote in Pennsylvania, also, due allowance must be made for the exposure of graft, incompetence and inefficiency in connection with the $50,000,000 good-roads bond issue in the State of New York. Past experience in Pennsylvania, moreover, in the conduct of public works has not been by any means reassuring to

the voters of the State as to the prospect that large appropriations of public money would be spent honestly for the benefit of the taxpayers. Those who are interested in promoting good roads may in good faith attempt to assure the taxpayers that their money will be honestly spent; but with the conflicting currents of partisan politics swaying him, it is not strange that the voter remains distrustful.

The vote in Pennsylvania teaches a lesson which should be taken to heart by those who are promoting the cause of good roads. The question we would raise is, why not, before asking the voter to sanction the expenditure of one or ten or fifty million dollars for road improvement, prepare a definite plan as to how and where the money is to be expended, and under what control the expenditure is to be made?

Suppose, for example, the legislature of Pennsylvania had first of all created a permanent good-roads commission, made up of men of high standing and wide reputation for business ability and integrity. Suppose such a commission had expended a reasonable appropriation in the laying out of a general plan of highway improvement, applicable to all parts of the State, so that the $50,000,000 or other sum provided should be, so far as possible, widely distributed. If the voters had then been asked to sanction such an expenditure as that just laid before them, understanding that the work would be under the control of a non-partisan commission of able business men, we believe there is little doubt that the vote in favor of the proposition would have been far greater.

## An Independent Opinion on the United States Reclamation Service

The engineering profession all over the United States, we believe, is especially desirous of knowing the truth concerning the United States Reclamation Service. We believe that on the whole the weight of engineering opinion is distinctly favorable to the Service. On the other hand, it is well known that many formidable attacks have been made upon it and it has been the target for the severest kind of criticism, both inside and outside of the profession. It has generally been conceded, even by the most rabid critics of the service, that its operations have been conducted with honesty; but it has been repeatedly charged with extravagance and incompetence.

The great body of engineers in the United States, residing thousands of miles away from the Reclamation Service operations, will welcome, we believe, an impartial and authoritative opinion as to what the Reclamation Service has accomplished. One reason why a correct opinion as to the Reclamation Service work is extremely important to the engineering profession is that the Service is the first attempt made by the Federal Government to establish a Federal system of public works in charge of a body of civilian engineers.

If it can be shown that the task undertaken by the Reclamation Service has been carried out with a high degree of success, it argues well for the extension of the work of engineers to larger fields in connection with our Federal public works. On the other hand, if the Reclamation Service can be shown to have been extravagant and inefficient in its work, then a strong weapon is placed in the hands of those who declare that the Federal government should keep its hands off from all public works and leave their execution to the States or to private enterprise.

There has just come to our attention a most interesting opinion upon the work of the Reclamation Service. The author of the opinion is Mr. H. T. Cory; and the opinion occurs in the course of a discussion by Mr. Cory on a paper by Mr. John H. Lewis, State Engineer of Oregon, on "State and National Water Laws," read before the American Society of Civil Engineers.

Mr. Cory held for many years an important position with the engineering department of the Harriman Railway Lines, and became widely known to the engineering profession through his remarkable work in stopping the crevasse in the banks of the lower Colorado River through which the waters of the Colorado escaped to the Salton Sea. Our readers will also recall Mr. Cory's able article in ENGINEERING NEWS of Dec. 7, 1911, reviewing the work done by the Federal government in attempting to check further encroachments by the Colorado River upon the lands at its delta.

While Mr. Cory is an engineer of wide experience, of large ability and of judicial mind, it must be said frankly that his predilections are, as is often the case with men who have spent most of their active years in corporation service, in favor of private enterprise in the operation of public utilities rather than in favor of government ownership and operation.

For instance, Mr. Lewis in the paper above referred to proposed that the Federal government itself should develop water powers on the public lands and undertake the generation, distribution and sale of electric power at cost. Mr. Cory, in the discussion of Mr. Lewis' paper, opposed such a scheme and urged that private ownership of public utilities with government regulation is far preferable to operation by the government itself. He stated, however, that irrigation work and the Reclamation Service in particular form a notable exception to this rule. In further discussing the work of the Reclamation Service he declared that on those parts of the Reclamation Work with which he is familiar, he believed *more actual work is obtained per dollar expended than is obtained on the Harriman Railway Lines.* We know of no engineer who could render such an opinion with a greater weight of authority than Mr. Cory; and it has seemed to us worth while, therefore, to reprint the substance of what he said regarding the Reclamation Service work as follows:

**The writer believes the conditions affecting the wisdom of Governmental construction and operation of power and irrigation projects in the West are fundamentally different. Power installations are almost invariably put in by well managed corporations, and the markets are in large part now supplied by private aggregations of capital. The U. S. Reclamation Service, on the other hand, always deals with projects which are entirely self-contained, and so do not affect the value of other privately or mutually controlled works, even if in the immediate vicinity. Furthermore, due to chaotic and most unwise laws, no well managed private capital would deal with the irrigation situations comprehensively or wisely. Private irrigation projects have with very rare exceptions fared so disastrously throughout almost the entire West that it is almost impossible to secure capital for such work. Indeed, that is one of the chief reasons for improved State and National water-right laws discussed in this paper.**

**The Reclamation Service has since its beginning expended about $75,000,000 in irrigation construction, and is now working at the rate of about $1,000,000 monthly. During the past season (1912) it was ready to supply water for about 1,200,000 acres out of 3,000,000 acres for which the works are being constructed. The cost per acre ranges from $22 to, in one instance, $95, with an average of between $50 and $60. In few if any, instances has any portion of such cost been paid as**

yet by the land owners, yet the selling price of land under the various projects—with the Government charges yet to be paid—has invariably increased, in some instances by more than $150 per acre. The works installed have uniformly been strictly first class, often monumental, sometimes possibly uneconomically so. In any event, the curse of Western irrigation—flimsy construction—has been avoided.

In short, the Reclamation Service has been doing a grand work, and if its operations were a measure of what might be expected of Government ownership as a whole, the proponents of such a policy would have a very strong, if not convincing, case. Its publicity department has been very efficient, but, on the other hand, it has gotten its result at a marvelously small outlay, and, even so, the people, for whom the primary purpose is supplying homes, are coming to the various projects all too slowly. This is almost entirely because the "back to the land" cry is a thing in which many join but few practice.

The Reclamation Service has made not a few mistakes—it would be miraculous if it had not considering the magnitude of its operations—and even many of its supporters feel that a frank admission of them would have made its position, among those whose opinions are worth while, stronger than it is.

Nevertheless, based on a fairly complete knowledge of only the Salt River, Yuma and Orland Projects of the Service, and the observation and study of data examined during eight years with the Harriman Lines in California, Arizona and Mexico—six years as a maintenance and operation official, with unusual opportunities to observe—the writer is convinced that, in these three projects at least, the Reclamation Servi[illegible]s more actual work for a dollar than do the Harriman [illegible].

Such a statement, of course, is a judgment reache[illegible] general way, because the character of the work done [illegible] two organizations is so fundamentally different as [illegible] permit of analytical detailed comparison item by item. [illegible]theless, the writer feels very positive in this judgme[illegible] could cite very many instances, some minor and some [illegible]mental, in support, though naturally many of the d[illegible] hand bearing on the matter could not properly be give[illegible].

Such a result is due to the fact that National politi[illegible] been eliminated from the Service, but still affects the H[illegible]man Lines somewhat; that the Director of the Servic[illegible] more authority and freedom in using his individual jud[illegible] than even Mr. Lovett of the railroads has, let alone the [illegible] presidents; that the head officials, and consequently the [illegible] eral ideas of management of these railroads, have [illegible] changed, and the Director of the Service has not; that [illegible] is much less internal politics in the Service; and the Se[illegible] organization and work, as yet at least, has not brought about the sharply drawn lines of cleavage between various departments and the leveling routine of "common standard" methods, channels of communication, limitations, prerogatives, etc., of the railroad.

The writer firmly believes that effective regulation of public utilities is greatly to be preferred to public ownership in general, and one important reason is the inefficiency of unwieldy organizations. The Reclamation Service is one of the smallest departments of the Government, and its efficiency is less than if it were smaller.

# LETTERS TO THE EDITOR

## The Desirability of Establishing Quantity Surveying in the United States

Sir: It is good news to many contractors to learn from your editorial on quantity surveying in the issue of Oct. 30, 1913, p. 877, that a definite move has been made toward the establishment of this all important aid to better estimating. It is of real importance to both owners and contractors that bids should be made upon a definite and known quantity of work to be done, as far as is reasonably possible. It is our belief that contractors for big engineering work would welcome a proper schedule of quantities to bid on as much as those who undertake smaller work. Where plans are incomplete or conditions are not definitely known, this is usually done by contracts based upon unit prices, but where plans are complete and conditions are known, it is assumed that quantities can be correctly computed by the contractors' estimators and so lump sum bids are asked for. The fallacy in this assumption lies in the fact that it is not possible for a contractor's estimator, however expert he may be, so thoroughly to understand and read the plans of the architect or engineer in one week (the time usually allowed), as to be able to scale them correctly. The architect or engineer generally spends some months working on his plans and they are his own designs. By the time they leave his hands he is perfectly familiar with every line in them and their meaning is clear to him. The contractor's estimator in one week has to become as familiar with the plans as the architect or engineer. He cannot do it and from this comes a large proportion of the mistakes in estimating which lead to irregular bids. It is our belief that as many losing contracts are taken on incorrect quantities as on bad judgment in pricing. This is not to anyone's advantage, for the owner is always willing to pay a fair price for the work. He only wants to be sure what that price is, and the engineer as a rule would much rather have a contractor working for a profit than trying to save a loss.

The question of guaranteeing the accuracy of the quantities does not seem to us to be of very great importance, because, as you state, if quantities are taken off by a disinterested authority, his reputation and standing will depend on the accuracy and usefulness of the work he does. Owners do not usually ask for a guarantee from their engineer that their buildings will not fall down, but they are just as careful to design permanent structures as if they had a financial risk in their stability. At the same time, the schedules of quantities sometimes put out by engineers on their own work, disclaiming all responsibility for their accuracy, are useless and are not what contractors require. In order to have quantities correctly taken out, they should be made by another disinterested party who is qualified to do this work. Such a man would, of necessity, have in view the fact that the quantities must represent the items that the contractors need to know in order to make up an intelligent price. For instance, concrete and forms for concrete, and reinforcement, should each be measured separately. Excavation should be properly classified according to its character. Brick work should be classified according to its character and face brick separated, and so on.

Before any system of quantity surveying becomes established in this country, it will be necessary to establish some definite units of measure on all classes of construction work, as there is a very wide variation in the prac-

tic of contractors' estimators at this time. In England there are at present two systems of measurement in vogue — the northern system, which is used in Scotland and the north of England, and the London system, which is used in the whole of the south of England and in Ireland. One of these two systems is used by every quantity surveyor. The American Concrete Institute has already made a start on standardization of measurements by drawing up the rules for measurement of concrete which were adopted at their last convention and appeared some months back in your columns.

ABERTHAW CONSTRUCTION CO.,
BY LESLIE H. ALLEN.

8 Beacon, St., Boston, Mass., Nov. 1, 1913.

## Flood Prevention in Different Localities

Sir—The letter published in ENGINEERING NEWS of Oct. 30, signed by J. Pluvius, indicates perhaps the need for a statement of the attitude of the Morgan Engineering Co., concerning flood prevention at Dayton, Ohio.

In discussing methods of flood prevention throughout the United States, there has been a tendency to generalize and to advocate one or another form of protection for the country as a whole, regardless of conditions in particular localities. We believe this to be fortunate, and we think that substantial progress in river control and flood prevention will come when we leave off generalities and deal with particular situations according to their conditions.

At the time of beginning our survey for flood prevention at Dayton, we were very skeptical about the possibilities for reservoir control. We have been convinced of the possibilities of this method through an examination of the physical conditions, but we have not yet come to the conclusion that reservoir control unaided by any other method of improvement is in all cases most feasible for the Miami Valley. While it happens in this case that flood prevention can be completely secured by rservoirs alone, it may be more economical to unite reservoir construction with other methods of improvement. The fact that we are considering reservoir control for the Miami Valley does not mean that it is equally applicable to other parts of the country.

Our surveys and examinations for flood protection plans in other parts of the United States indicate to us that there are unsuspected opportunities for reservoir construction on many of our streams, but that in many other cases this method of improvement is entirely impracticable.

The extreme range of local conditions may be seen by the fact that the reservoir system at the headwaters of the Mississippi River was constructed at a cost of $8 per million cubic feet of storage. The estimated cost of reservoir storage in the Miami Valley is about $300 per million cu.ft., and in the Scioto Valley somewhat more than twice this amount, while in Europe the cost of storage capacity in reservoirs commonly amounts to from $1000 to $6000 per million cu.ft. One European writer gives $3500 per million cu.ft. as an average price. Although it is found economical in Europe to build storage reservoirs at these comparatively high costs, yet by far the larger part of river control improvement in Europe follow other methods.

If the probable cost per unit of storage had not been much less on the Miami watershed than on the Scioto watershed, it is possible that reservoir control would not have been seriously considered in the former case.

MORGAN ENGINEERING CO.,
ARTHUR E. MORGAN, President.

Dayton, Ohio, Nov. 1, 1913.

## NOTES

**The Wreck of the Marseilles-Paris Express,** by collision with a local train, near Melun, France, on Nov. 4, caused the death of 32 persons and the injury of 40 others.

**A Collision** between a passenger train and a repair train on a branch line of the Panama R.R., eight miles from Panama, resulted in the death of six persons. According to press dispatches the accident was due to the repair train running on the same schedule as the passenger train.

**The Walls of a 5-Story Warehouse Collapsed** in Hartford, Conn., on Nov. 3, as the result of an explosion within the building. The brick walls toppled over on the roof of two adjoining wooden tenements, killing seven persons. The cause of the explosion is not known; it was followed by a fire, which was soon extinguished.

**An Electric Car Was Suspended** by the rear trucks, at an angle of about 45°, from the pier of an open drawbridge, on Oct. 31, at Toledo, Ohio. According to press dispatches, the motorman stated that he failed to notice that the Erie St. drawbridge was open until he was less than one block distant; he then applied the brakes and opened the sand-valve, but the wheels failed to take hold on the slippery rails and the car did not stop until half over the bridge pier. Four persons were injured.

**A Loading Platform Collapsed** in the Lexington Ave. subway excavation, at Broadway and Waverly Place, New York City, on Nov. 10. The platform, which was 25 ft. below street level and 4 ft from the bottom of the excavation, was loaded with sand and several iron buckets used to transport the sand to the street above. Two men, working under the platform at the time of its collapse, were killed. The excavating at this point is being performed by the Dock Contracting Co., of Hoboken.

**A Fire in a Ship's Coal Bunker** burned for four days, until port was reached. The "Jan van Nassau," a new vessel owned by the Royal Dutch West India Co., and bound for the West Indies, was only a few days out of Amsterdam, Holland, when the fire was discovered. The fire-fighting apparatus was of little avail and the flames spread to the cargo compartments. The vessel was turned toward the nearest land, St. Michael, W. I., where the fire was extinguished with a loss of 800 tons of freight and all the coal in the bunkers.

**The Chicago Garbage Reduction** plant of the Chicago Reduction Co. is to be acquired by the city by condemnation proceedings, according to the latest move. Before taking this step the city authorities offered the company $133,000 for the plant, but this offer has been refused. A new party on the scene is the Illinois Rendering Co., which is said to have contracted to purchase the other company's plant and intends to spend $125,000 on improvements. According to report it will ask the city for a five-year contract to handle the garbage without cost to the city, but the city to do the collecting and to deliver the garbage at the plant.

**An Electric Railway Accident** occurred Oct. 22 on the Aurora, Elgin & Chicago Ry., a third-rail interurban line. A work train was running west from Wheaton to Aurora, and a heavy steel shaft and gear wheel being carried on the rear car fell off and lay upon the track without being noticed by the train crew. About 15 min. later, at 5:45 a.m., an empty two-car train followed, running at high speed, and owing to the fog and frost the motorman did not see the obstruction until just as the car struck it. Of the four trainmen, one jumped and alighted safely, but just as he was getting to his feet the front car fell over on him and crushed him to death. The second car was derailed but not overturned. The other men were not badly hurt.

**The Fifty-Million Dollar Bond Issue** for good roads in Pennsylvania was defeated by 59,556 majority at the election of Nov. 4. Philadelphia cast 44,655 majority in favor of the proposition, and in half a dozen other counties a small majority in favor was recorded, but all the other counties of

the state cast heavy majorities against the loan, Lancaster County leading with a majority of 11,522. In some of the counties the vote was 6 to 1 against the proposition.

**The Australian Capital Competition**—The following note is from the October, 1913, issue of "The Commonwealth Engineer," published at Melbourne.

At the request of the Commonwealth Government W. B. Griffin, of Chicago, U. S. A., the first prize winner in the Federal capital design competition, has visited Australia to consult with the departmental board which prepared the design accepted by the late Minister for Home Affairs, which includes many of the features of Mr. Griffin's original plans. It is understood that Mr. Griffin has somewhat modified his ideas after visiting the capital city site, but does not care to amend his plans to the extent suggested by the departmental board which consists of the following: Mr. D. Miller, Administrator of the Federal Territory; Mr. P. T. Owen, Director-General of Works; Mr. C. R. Scrivener, Director of Surveys; Mr. J. G. Oakeshott, Director of Works in New South Wales; Mr. J. S. Murdoch, architect in the Home Affairs department; and Mr. T. Hill, Director of Works in Victoria. Mr. Griffin's return to America has been postponed for a month, and in the meantime he will supply the Minister with a full report on the subject.

**Work on the New Quebec Bridge** across the St. Lawrence River at the site of the large bridge which collapsed in August, 1907, has been going on all summer. Practically all of the masonry work on the piers is now completed and progress is being made in the erection of the approaches, and of the steel falsework for the anchor spans. The steelwork is being fabricated in an entirely new shop at Montreal, near the shop of the Dominion Bridge Co. This new shop was built especially for the Quebec Bridge by the St. Lawrence Bridge Co., a newly organized company holding the Quebec Bridge contract. It has a capacity of about 2000 tons per month.

All drafting, designing, etc., for the bridge is being done in Montreal by the St. Lawrence Bridge Co. under the direct supervision of the Board of Engineers, but when the shop designing is completed the whole office will be moved to or near the bridge site.

On account of the severity of the St. Lawrence winter work is shut down toward the first of December not to be resumed until spring. When construction is started again in 1914, it is expected that erection will be prosecuted from both sides of the river and that the approaches will be completed by the end of next season. No estimate is made as to the time of completion of the anchor arms or of the entire bridge.

**A 13,500-Hp. Hydro-Electric Plant was Wrecked,** according to press reports and correspondence, at Ogden, Utah, on Oct. 26, by mistake or accident in opening a control valve. Two new 3750-hp. Francis turbines had just been installed in the plant, together with a 72-in. steel penstock. Apparently one of the quarter-turn discharge casings had been removed with the water-supply held back, under 450-ft. head, only by a 24-in. double-faced motor-operated valve in the branch pipe from the penstock. The valve-motor circuit probably was closed by an employee showing the plant to visitors. The valve opened and water escaped into the room, short-circuiting some of the equipment; the valve could not be shut by its electric control, but was closed by hand whereupon it broke—evidently from excessive pressure due to "water hammer." A second 24-in. valve in the turbine intake is reported to have developed a broken seat at this critical juncture and could be only half closed. Resort was next made to the station penstock valve, hydraulic operated only; this only partially closed on account of balanced pressures. Finally, the intake valve to the 6000-ft. pipe line was closed by the efforts of employees; water flowed, of course, until the pipe was empty and in emptying the wood-stave line collapsed in three places.

The station building filled with water which first escaped only at the upper windows and cornice openings some 45 ft. above ground, but later the lower openings burst open and let the water out, temporarily flooding several blocks in the vicinity. A part of one curtain wall of the station building was ripped out. All car traffic was stopped and the city was largely dark for six hours. No close estimate of the damage done is available, but it is reported to be from $50,000 to $100,000.

**The Gradings in the Examinations** for engineering positions under the Railway Valuation Board of the Interstate Commerce Commission have been completed by the Civil Service Commission, and the individual grades have been announced to the men attaining them. The Civil Service Commission has furnished us the following statement in regard to the examinations.

The Interstate Commerce Commission for the purposes of railway valuation work has divided the United States into the following districts:

District I—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Delaware, District of Columbia, West Virginia, Virginia and North Carolina.

District II—Ohio, Indiana, Kentucky, Tennessee, Alabama, Mississippi, Georgia, South Carolina, Florida, Panama and Porto Rico.

District III—Michigan, Wisconsin, Minnesota, Iowa, Illinois, Louisiana and Arkansas.

District IV—North Dakota, South Dakota, Nebraska, Colorado, Kansas, Missouri, Oklahoma and Texas.

District V—Montana, Wyoming, Utah, Idaho, Nevada, Washington, Oregon, California, Arizona, New Mexico and Alaska.

These districts are adopted for purposes of certification. Certification for appointment in any district will be made of the highest eligibles examined in that district, except that upon request of the Interstate Commerce Commission certification may be made of the highest eligibles on the register for the entire country who have expressed willingness to accept appointment where the vacancy exists. When there is a lack of eligibles in any district, eligibles in adjoining districts may be certified.

The Commission is required, under the rules, in response to properly authorized requests, to certify from the head of the appropriate register, a number of names sufficient to permit the appointing officer to consider three names in connection with each vacancy. He may select any one of the eligibles so certified, the two remaining, together with the fourth eligible, constituting the second group of three from which selection is to be made. Further selections are made in like manner.

The Commission cannot accurately estimate the prospects of an eligible for appointment as it ordinarily has no knowledge of vacancies in advance of receipt of requests for certification.

Below is given a table showing the distribution of gradings in three of the higher classes.

| SENIOR CIVIL ENGINEERS. | Above 90 | 80 to 90 | 70 to 80 |
|---|---|---|---|
| District No. I: | | | |
| First grade | 15 | 82 | 53 |
| Second grade | .. | 26 | 86 |
| District No. II: | | | |
| First grade | 12 | 35 | 32 |
| Second grade | .. | 14 | 32 |
| District No. III: | | | |
| First grade | 8 | 53 | 29 |
| Second grade | .. | 22 | 43 |
| District No. IV: | | | |
| First grade | 10 | 38 | 36 |
| Second grade | .. | 32 | 46 |
| District No. V: | | | |
| First grade | 9 | 43 | 26 |
| Second grade | .. | 13 | 65 |
| Total | 54 | 358 | 448 |
| SENIOR STRUCTURAL ENGINEERS. | | | |
| First grade | 12 | 28 | 17 |
| Second grade | .. | 22 | 27 |
| SENIOR RAILWAY SIGNAL ENGINEERS. | | | |
| First grade | 2 | 13 | 3 |
| Second grade | .. | 6 | 31 |

## PERSONALS

Mr. W. H. Rupp has been appointed Chief Engineer of the Sumpter Valley Ry., with headquarters at Baker City, Ore.

Mr. George H. Funk, recently Superintendent of Fuel Economy of the Chesapeake & Ohio Ry., has been appointed Chief Smoke Inspector of the city of Cincinnati, Ohio.

Mr. W. J. Frey has been appointed Supervisor of Materials of the Lake Shore & Michigan Southern Ry., with headquarters at Cleveland, Ohio, succeeding Mr. H. W. Gartner, resigned.

Prof. C. M. Carson, formerly head of the department of chemistry at the University of New Brunswick, Canada, has been made head of the department of chemistry at the Michigan College of Mines.

Mr. Leo G. Smith, Superintendent of the openhearth works of the Prime Steel Co., Milwaukee, Wis., has been promoted to be Works Manager of the openhearth and the crucible steel plants of the company.

Mr. F. L. Burckhalter, District Engineer of the Southern Pacific Co., at Portland, Ore., has been appointed Chief Engineer of the Portland, Eugene & Eastern Ry., a subsidiary of the Southern Pacific Co.

Lieut. Frederick Mears, Assoc. M. Am. Soc. C. E., Chief Engineer of the Panama R.R., Christobal, Canal Zone, Panama, is Acting General Superintendent during the temporary absence of Mr. J. D. Patterson.

Mr. Walter V. Appleton, formerly Assistant to the Superintendent of Motive Power of Intercolonial Ry., of Canada, has been promoted to be General Master Mechanic, with headquarters at Moncton, N. B.

Mr. G. A. Bradley, recently Trainmaster of the Georgia-Alabama division of the Seaboard Air Line Ry., has been appointed Division Superintendent of the Norfolk Southern Ry., with headquarters at Norfolk, Va.

Messrs. Harry Hawgood, M. Inst. C. E., and Gervaise Purcell, Assoc. M. Inst. C. E., of Los Angeles, Calif., have been awarded Telford Premiums of the Institution of Civil Engineers for papers during the 1912-13 session.

Mr. John Rourke, recently Assistant Superintendent of the Boston & Maine R.R., at Concord, N. H., has been promoted to be Superintendent of the Portland division, at Portland, Maine, succeeding C. E. McMullin, resigned.

Mr. August F. Blaess, recently District Engineer of the Yazoo & Mississippi Valley R.R., at Memphis, Tenn., has been promoted to be District Engineer of the Illinois Central R.R., at Chicago, Ill., succeeding Mr. James Clifford, resigned.

Mr. D. W. Campbell, of Portland, Ore., has been appointed General Superintendent of the Portland, Eugene & Eastern Ry. Mr. Campbell is General Superintendent of the Southern Pacific Co., of which the Portland, Eugene & Eastern Ry. is a subsidiary.

Mr. R. G. Kenly, Chief Engineer of the Minneapolis & St. Louis R.R., has been appointed Chairman of the railway company's valuation committee. The other members of the committee are Messrs. L. G. Scott, Auditor, and C. F. Foot, Land and Tax Agent.

Mr. A. B. Warner, Vice-President and General Superintendent of the Chicago, Rock Island & Gulf Ry., has been appointed Chief Engineer in addition to his present duties, with office at Fort Worth, Tex., succeeding Mr. H. M. Stone, M. Am. Soc. C. E., resigned.

Mr. F. B. Wiegand, formerly Assistant Signal Engineer of the Lake Shore & Michigan Southern Ry., at Cleveland, Ohio, has been promoted to be Signal Engineer of the New York Central Lines, succeeding Mr. C. E. Denny, promoted, as noted in our issue of Oct. 23.

Mr. T. N. Jacob, M. Am. Soc. C. E., has resigned as Chief Engineer of the East Side Levee and Sanitary District, East St. Louis, Ill., to become Chief Engineer of a levee district near Chester, Ill. The construction work of the East Side Levee and Sanitary District has been practically completed.

Mr. G. F. Collister, for the past three years Assistant to the General Superintendent of the Cleveland Twist Drill Co., Cleveland, Ohio, has been appointed Engineer of Sales of the tool-steel department of the Betz-Pierce Co., of Cleveland. Mr. Collister is a graduate of Case School of Applied Science, class of 1905.

Mr. Clarence D. Pollock, M. Am. Soc. C. E., recently Chief Engineer of paving, Calle Cuba 24, Havana, Cuba, has been appointed Chief Engineer of the department of paving of the city of San Antonio, Tex. Mr. Pollock is a native of Brooklyn, N. Y., and a charter member of the Brooklyn Engineers' Club.

Mr. R. F. Armstrong, Assistant Superintendent of the Chicago & Northwestern Ry., at Antigo, Wis., has been promoted to be Superintendent of the Iowa & Minnesota division, with office at Mason City, Iowa, succeeding Mr. H. Rettinghouse, who resigned, as noted in our issue of Oct. 30, to become Chief Engineer of the Chicago, St. Paul, Minneapolis & Omaha Ry.

Mr. F. H. Newell, M. Am. Soc. C. E., is Director of the United States Reclamation Service and under the present scheme of administration is the head of a commission of five, the other members of which are: Mr. A. P. Davis, Chief Engineer; Judge Will R. King, formerly Justice of the Supreme Court of Oregon, Chief Counsel; Mr. W. A. Ryan, formerly with the Interstate Commerce Commission, Comptroller; and Mr. I. D. O'Donnell, of Montana, a practical irrigation project manager, Supervisor of Irrigation.

Mr. Mortimer M. Cooke, Assoc. M. Am. Soc. C. E., has resigned as Assistant Engineer on railway valuation of the California Railroad Commission, and has opened offices in the Southwestern Life Bldg., Dallas, Tex., to engage in private practice as a specialist in the preparation of data and reports on the value of railway properties (other than the large systems) for presentation to the Interstate Commerce Commission in connection with the requirements of the recent Railway Valuation Act. Mr. Cooke was formerly Chief Engineer of the Wichita Falls & Northwestern Ry. System.

Mr. John C. Gotwals, Jun. Am. Soc. C. E., a civil-engineering graduate of the Pennsylvania State College, class of 1906, and former Assistant Engineer, Board of Water Supply, City of New York, was commissioned Second-Lieutenant, Corps of Engineers, U. S. A., on Mar. 3, 1913. It was erroneously stated in our issue of Oct. 30 that Lieut. W. M. Chubb was the only member of the Corps of Engineers who was not a graduate of the U. S. Military Academy at West Point. Lieut. Gotwals is at present on duty with Company H, Second Battalion of Engineers, Texas City, Tex. So far as we are able to determine, these two men are the only "civilian" officers in the Corps of Engineers, U. S. A.

Mr. D. L. Reaburn, M. Am. Soc. C. E., former Division Engineer of the Saugus division of the Los Angeles (Calif.) aqueduct, and more recently in railway location work in the Argentine Republic, has opened an office in the Central Bldg., Los Angeles, for the practice of civil engineering, specializing in topographic and location surveys, plans, estimates and construction for systems of roads, water supply, irrigation, etc. Mr. Reaburn studied engineering at the Universities of Illinois and Wisconsin and has had a wide and varied experience. In the past 20 years he has served with the Mississippi River Commission, the U. S. Geological Survey, the United States and Canada Boundary Survey, the U. S. Reclamation Service, the Los Angeles Aqueduct and the Argentine Government.

Mr. A. C. Ridgway, Vice-President of the Chicago, Rock Island & Pacific Ry., has been elected President of the Arkansas & Memphis Railway Bridge & Terminal Co. Mr. Ridgway succeeds Mr. H. V. Mudge, President of the Chicago, Rock Island & Pacific Ry. as head of the terminal company, which is constructing a large cantilever bridge across the Mississippi River at Memphis (described in our issue of last week) and terminals there. The new board of directors of the company consists of Messrs. Ridgway and E. S. Moore, Vice-Presidents of the Chicago, Rock Island & Pacific Ry.; E. J. Pearson, M. Am. Soc. C. E., and Alexander Robertson, Vice-Presidents of the Missouri Pacific Ry.; and F. H. Britton, Vice-President, and C. D. Purdon, M. Am. Soc. C. E., Chief Engineer, of the St. Louis Southwestern Ry.

Mr. John H. Darling, M. Am. Soc. C. E., of Duluth, Minn., has retired after 40 years of service as Assistant Engineer and Principal Assistant Engineer in the United States Engineer Department. On the day of his retirement, Oct. 31, he was presented with a handsome silver loving cup by his fellow workers in the United States Engineer Office at Duluth. The presentation speech was made by Mr. Clarence Coleman, M. Am. Soc. C. E., U. S. Assistant Engineer, who referred to Mr. Darling as "the dean of engineers of the Great Lakes." Mr. Darling graduated in civil engineering from the University of Michigan in 1873 and immediately entered the government service as a sub-assistant engineer. For a number of years he was engaged in geodetic survey work on the Great Lakes. Later he had charge of a party near Memphis, Tenn., on Mississippi River work. Since 1884 he has been continuously engaged in harbor improvement work on the Great Lakes, being stationed all that time at the Duluth office. For the last 16 years he has been Principal Assistant Engineer.

Mr. J. E. Stephens, Chief Engineer of the Missouri Pacific Ry. System, has been appointed General Chairman of the valuation committees of the Missouri Pacific Ry., the St. Louis, Iron Mountain & Southern Ry., the Denver & Rio Grande Ry. and the Western Pacific Ry. His headquarters will be at St. Louis, Mo. Mr. Stephens has supervision of the work of valuation committees for each of these lines as follows: the Missouri Pacific Ry. and the Missouri, Iron Mountain & Southern Ry., Messrs. C. E. Smith, M. Am. Soc. C. E., Assistant Chief Engineer, Chairman; T. L. Philips, Attorney; F. P. Johnson, Accountant, and R. J. Turnbull, Mechanical Superintendent, with offices at St. Louis, Mo.; the Denver & Rio Grande Ry., Messrs. Arthur O. Ridgway, M. Am. Soc. C. E., Assistant Chief Engineer, Chairman; J. G. McMurry, Attorney; E. R. Dickerson, Accountant, and J. F. Enright, Superintendent of Motive Power, with offices at Denver, Colo.; the Western Pacific Ry., Messrs. T. J. Wyche, Chief Engineer, Chairman; A. P. Matthews, Attorney, J. F. Evans, Accountant, and J. F. Enright, Superintendent of Motive Power, with offices in San Francisco, Calif.

Mr. Charles F. Howe, Assoc. Am. Inst. E. E., Consulting Engineer, of Macon, Ga., has been appointed Chairman of a Committee on Water Power and Water-Power Developments of the Georgia Chamber of Commerce. Other members of the committee are: Messrs. S. W. McCallie, M. Am. Inst. M. E., State Geologist, Atlanta; B. M. Hall, M. Am. Soc. C. E., Consulting Engineer, Atlanta; Paul H. Norcross, Assoc. M. Am. Soc. C. E., of the Solomon-Norcross Co., Atlanta; G. F. Har-

ley, Assoc. M. Am. Soc. C. E., Hydraulic Constructing Engineer of Columbus; W. A. Carlisle, of the North Georgia Electric Co. and the Georgia Power Co., of Gainesville; Nisbet Wingfield, M. Am. Soc. C. E., City Engineer, of Atlanta; Charles A. Caldwell, M. Am. Soc. C. E., Consulting Engineer, of Macon, and C. D. Flannigan, of Athens. It is the purpose of this committee to point out to and enlighten the general public, particularly farmers and capitalists, on the possibilities of electric power generated by water power, to attract manufacturing industries to the state, and to show the possibilities of irrigation as applied to intensive farming.

## OBITUARY

Timothy Nester, a railway contractor and former Mayor of Marquette, Mich., died Nov. 3. He was 67 years old.

William Francis Tatnall, President of the Tatnall Engineering Co., Philadelphia, Penn., died Oct. 26, from angina pectorus. He was in his 51st year.

W. G. Carbaley, for the past 10 years Superintendent of the Eureka Water Co., Eureka, Calif., died recently. He was formerly Superintendent of what is now the Southern division of the Northwestern Pacific R.R. Before going to the Eureka Water Co. he superintended the building of the first breakwater at Humboldt Bay.

Horace G. Merrick, Junior Engineer, U. S. Engineer Department, employed in river-improvement work under Mr. W. A. Thompson, M. Am. Soc. C. E., U. S. Assistant Engineer, La Crosse, Wis., died from typhoid fever, Oct. 30. Mr. Merrick was born at Manistee, Mich., where he received his preliminary education in the public schools. He graduated from the University of Michigan in civil engineering and entered the employ of the U. S. Lake Survey, where he remained until 1907. Since 1907 he has been attached to the La Crosse office under Mr. Thompson.

Jacob Johann, former Superintendent of Machinery of the Chicago & Alton R.R., died Nov. 3, at his home in Springfield, Ill. He was born in 1830 in Bavaria, Germany. After 12 years' experience on locomotives, his engineering work began in 1858 as assistant to the Master Mechanic of the Missouri Pacific R.R. He was promoted to be Master Mechanic and General Master Mechanic of this and other Central Western railways. From 1888 to 1892 he was in charge of the Chicago, Ill., office of the Safety Car Heating & Lighting Co. From 1892 to 1897 he was Superintendent of Machinery of the Chicago & Alton R.R.

Sir William Henry Preece, Past-President of the Institution of Civil Engineers, a famous British electrical engineer, died at his home in London, England, Nov. 6, in his 80th year. He was Chief Engineer and Electrician of the Post Office Department, 1892-1899, and for several years following was Consulting Engineer to the General Post Office and the Colonies. He was an authority on telegraphy and telephony and the author of textbooks on these subjects. Sir William Henry Preece was born in Wales, Feb. 15, 1834. He was educated at King's College, London, and at 18 years of age began his engineering training and experience in the office of Edwin Clark, M. Inst. C. E. The following year, 1853, he entered the employ of the Electric & International Telegraph Co., and in a few years was promoted to be Superintendent of the company's Southern District. He then served for a time with the London & Southwestern Ry., in the signal and telegraph department, and also as Engineer of the Channel Islands Telegraph Co. In 1870 he received the appointment of Division Engineer of the Post Office Department; in 1877 he was advanced to the office of Electrician, and in 1892 to that of Engineer-in-Chief. Sir William Henry Preece was also a Past-President of the Institution of Electrical Engineers and a member of the Institution of Mechanical Engineers.

Adelbert B. Stetson, former Vice-President of the Bucyrus Co., Milwaukee, Wis., died Oct. 27, aged 72 years. Mr. Stetson's connection with the Bucyrus Co. dated from 1888 when he became superintendent of the old plant in Bucyrus, Ohio. He superintended the construction of the new plant in South Milwaukee, Wis., and was General Superintendent for ten years, becoming Vice-President of the company in 1901. For the greater part of his life, Mr. Stetson was identified with various dredging and gold-mining interests. In 1904 he resigned as Vice-President of the Bucyrus Co. to devote his time exclusively to these interests. A few years later he again became associated with the Bucyrus Co. as Consulting Engineer, in which capacity he remained until his death. During the last year much of his time was devoted to the supervision of gold-dredging operations in Idaho. About a month ago, while so engaged, a severe illness necessitated his return to Milwaukee where the operation took place which culminated in his death. Mr. Stetson served through the Civil War and at the suspension of hostilities, was honorably discharged with the rank of Colonel. He was one of the first Americans to be identified with the construction of the Panama Canal. During the early 80's he spent several years on the Isthmus upon a contract which he had secured under the old French company. He was closely identified with the operation and manufacture of gold dredges ever since the birth of the industry in this country. During his connection with the Bucyrus Co. he had occasion to visit all parts of North and South America in the investigation of various dredging and mining propositions. In all his associations, both social and professional, Mr. Stetson had a peculiar faculty of endearing himself to all those with whom he came in contact. The memory of this splendid type of "a gentleman of the old school" will be long remembered by the host of dredgemen who have been proud to hold themselves his friends. [Extract from the "Excavating Engineer," November, 1913.]

## ENGINEERING SOCIETIES

### COMING MEETINGS

NATIONAL CONSERVATION CONGRESS.
Nov. 18-20. Annual meeting at Washington, D. C. Secy., T. R. Shipp, Indianapolis, Ind.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 1-2. Annual meeting in New York. Secy., W. H. Reed, 154 Nassau St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 2-5. Annual meeting in New York. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 8-11. Annual meeting in New York. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Penn.

SAND-LIME BRICK ASSOCIATION.
Dec. 9-10. Annual meeting at Harrisburg, Penn. Secy., W. E. Plummer, Jr., 211 Fillmore Ave., Buffalo, N. Y.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 9-12. Annual convention at Philadelphia, Penn. Secy., W. H. Tolman, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 10-13. Annual meeting in New York. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 11-12. General meeting in New York. Secy., D. H. Cox, 29 W. 39th St., New York City.

**Western Society of Engineers**—At the meeting held in the Society's rooms, at Chicago, on Nov. 3, Dr. John F. Hayford, of the Engineering College, Northwestern University, presented an exceptionally interesting paper on "Measuring the Earth." This related largely to the instruments and field operations of the U. S. Coast & Geodetic Survey, and gave examples of the remarkable degree of accuracy attained in these surveys and measurements. The paper developed a protracted discussion.

**Engineers' Club of Cincinnati**—For the ensuing year, A. L. DeLeeuw, and J. T. Faig were elected chairman and secretary, respectively.

**National Municipal League**—The 19th annual meeting of the league and the 21st conference for good government will be held at Toronto, Ont., Nov. 11-15. An interesting feature should be the report of the special committee on the Commission form of government for cities. The secretary is C. R. Woodruff, North American Building, Philadelphia, Penn.

**National Housing Association**—The third national conference on housing in America is to be held at Cincinnati, Dec. 3-5, under the auspices of the National Housing Association, the city of Cincinnati and the housing committee of the Cincinnati Chamber of Commerce. The topics to be considered include "Transit and Housing," "Garden Cities," "Restricted Residence and Business Districts in German Cities," and "Housing of Workers at Industrial Plants." The secretary is John Ihlder, 105 E. 22d St., New York City.

**American Society of Heating and Ventilating Engineers**—Samuel R. Lewis has been nominated for president for the ensuing year.

**American Society of Agricultural Engineers**—The 7th annual convention will be held at Chicago, Ill., Dec. 29-31, at the Great Northern Hotel. Among the papers to be presented, the following are of especial interest to engineers: "Farm Sanitation, with Special Reference to Water Supply"; "Standardization of Wagon Whels and Tires," and "Concrete in Drainage and Irrigation."

# ENGINEERING LITERATURE

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## REVIEWS

### A New Book on Highway Engineering

Reviewed by S. WHINERY*

TEXT-BOOK ON HIGHWAY ENGINEERING—By Arthur H. Blanchard, M. Am. Soc. C. E., Professor of Highway Engineering, and Henry B. Drowne, Assoc. M. Am. Soc. C. E., Instructor in Highway Engineering; Columbia University. New York: John Wiley & Sons, Inc. London, England: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xiii + 761; 234 text illustrations and 4 charts. $4.50. 19/-, net.

In any rapidly growing and developing art or industry books upon the subject, however complete and satisfactory at the time of their publication, soon become more or less obsolescent. Succeeding uptodate treatises are necessary from time to time and should not only contain all that is of permanent value in their predecessors, but should cover the advances made in the meantime. The art, or science, or industry of designing and building highways is an example. Comparison of the early editions of Gillespie's "Roads and Railroads," the first American text-book on highways, with the rather ponderous volume here reviewed affords striking evidence of the enormous development of road building and its literature in little over half a century.

Notwithstanding that an unusually large percentage of the text is made up of abstracted and quoted matter the volume represents a vast amount of industry and labor on the part of the authors. Its 27 chapters purport to and do fairly well cover the whole field of the design, construction and maintainance of highways and their appurtenances, including, incidentally, much relating to street pavements.

Any systematic and detailed review of the contents of so large and important a book is impossible within the limits of space permitted. Briefly, it will be found to be a veritable cyclopedia, not only for the professional engineer, but for the intelligent general reader in search of the latest information and best current practice on the subject of highways. The words, current practice, are used purposely, for the reader will note the relatively small attention the authors give to the underlying theory and mathematics of the subject, as compared with some authors. To an unusual extent also the authors have modestly preferred to advance the views and opinions of others rather than their own.

Much space seems to be given and especial importance attached to the proceedings of the various technical societies and to reports of their committees. This is entirely proper, though the reader should bear in mind that committee reports, while expressing the views of selected and especially able men, and therefore very valuable, do not always represent the aggregate judgment of the societies appointing them. Thus, the reports of special engineering committees of the American Society of Civil Engineers, while open to discussion by the membership, are never "adopted" by the Society, nor does it assume any responsibility for the data or opinions contained in such reports; while in the case of some of the other technical societies it is well known that committee reports are sometimes formally "adopted" without sufficient consideration, and do not always represent the deliberate judgment of the membership.

In most respects the treatment of the various phases of the whole subject of what is popularly called "Good Roads" is quite full and in a number of ways marks a distinct advancement on the previous literature of the subject.

The importance of certain elements of good practice in highway work is properly emphasized to an extent not common in other books. The book opens with a very interesting historical review. The brief reference to the famous Cumberland Road may give the reader a somewhat erroneous impression of its history, at this time, when the building of highways at National expense is being so strongly advocated in some quarters. This great road was not, as a whole, constructed by the National Government, and while it is true that various direct appropriations were made for it by Congress, the great bulk of its cost was provided for from the proceeds of the sale of public lands in the states through which it passed.

The subject of the importance of censuses of travel as an element in designing roads and pavements and the methods of conducting such censuses is more fully covered in this than in any previous book. Having been one of the earliest to advocate and introduce on a workable scale such censuses, and having a strong appreciation of their value, the reviewer is pleased to see that this branch of the subject is now receiving deserved attention.

The chapter on Design of Highways is very full and valuable.

In all, some 250 pages are devoted to the subject of bituminous materials and bituminous roads and pavements, and the treatment of this field of highway work is exhaustive and, generally, quite satisfactory. One or more chapters are devoted to each of the leading kinds of pavement, including wood-block, stone-block, brick and concrete, and one chapter is devoted to a rather meager account of miscellaneous roads and pavements.

Street Cleaning and Snow Removal; Car Tracks; Pipe Systems; Comparison of Roads and Pavements; Sidewalks, Curbs and Gutters; Bridges, Culverts and Guard Rails; and Economics, Administration and Legislation, each occupy a chapter.

The comparison of the merits and demerits of the various kinds of roads and pavements is not as complete and broad as the subject deserves, either in data or deductions therefrom. A table in the usual form, assigning a numerical scale of values to the relative merits of the various kinds of road surfaces (p. 653) is liable to give wrong impressions, because, principally, of its incompleteness. If the columns of assigned values for each kind of pavement for the several qualities considered be summed up the totals will not correctly represent the relative merits of that pavement. Thus, an aggregate rating value of 34 for earth and 39 for wood-block pavement on concrete is obviously misleading, as is also a ranking of 42 for hydraulic concrete pavement and only 29 for stone-block on concrete. Nor will most engineers agree that bituminous concrete is more meritorious than sheet asphalt.

In fact, the whole subject of the economics of roads and street pavements is so inadequately treated that this must be considered the weakest part of the book. For one of the most important duties of the road engineers of the country is to point out, demonstrate and force upon the attention not only of the public but of many of their professional brethren the utter wastefulness of spending money for

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building cheap but comparatively worthless roads, or for unintelligent experimentation in the vague hope that something may be found as cheap as the cheapest, and as good as the best; and that sane road building lies in the direction of utilizing established knowledge and experience and not in pursuing every ignis fatuus that may be proposed.

Notwithstanding the great value and many merits of the book there are numerous details that are open to criticism, and the reader is likely to note evidences of hasty composition, careless expression and inaccurate statements. The English is not always up to the standard one expects from members of a college faculty. Such defects and lapses are, however, unimportant unless they convey erroneous ideas. In the chapter on foundations the quotation of a table of the permissible static loads on various foundation materials may be quite misleading when applied to road subfoundations, where the loads are usually very "live." Also (p. 137) it is said: "The best and strongest concrete will result when the sand is sufficient in quantity to just fill the voids in the stone, and enough cement is used to fill the voids in the sand and stone." The authors presumably meant to say that the best and strongest concrete will result when the cement is sufficient in volume to fill the voids in the sand and when the mortar made therewith is just sufficient to fill the voids in the stone, but most competent engineers agree tht there should be some excess both of cement and mortar. The tabular statement of "cubic yards of broken stone from 1 cubic yard of solid rock," with stated percentages of voids, is true for crusher-run stone only; for it is obvious that if everything under ½ in. in size be screened out and rejected the percentage of voids will be changed, and the volume produced from 1 cu.yd. of solid rock will be decreased.

In the matter of nomenclature some of the definitions framed by the authors are more notable for their brevity than for their adequacy or accuracy. Thus the definitions of Highways and Pavements on page 18 are not only clumsy but are wanting in completeness and accuracy.

"One size crusher stone" (p. 416) is apparently used for the ordinary term, crusher-run. "Malthas are very viscous bitumens" (p. 262) is a true statement, but not a correct definition of maltha.

The authors cannot be held strictly responsible for quoted matter, but might be expected to exercise some care in selecting quoted definitions for adoption. Among these are found: "Rock Asphalt is a term applied to a great variety of sandstones and limestones more or less impregnated with maltha" (p. 262). This would exclude the most important rock asphalts of the world—those of Europe—since the bitumen in them is not maltha. The definition of tars (p. 262) read in connection with that of pitches on the succeeding page, quoted from the same authority, would seem to imply that all bitumens are tars and all residues from their distillation are pitches.

Under the sub-head Gilsonite Asphalt (p. 277) the manufacture of blown oil bitumens is described, ending with the quoted statement that this material needs the addition of other bitumens, and that "Gilsonite, a pure native bitumen, readily combines with the blown oil." This is certainly not an adequate treatment of the important bitumen, Gilsonite.

On page 376 under the sub-head Disadvantages (of bituminous surfaces) the statement that "Among the disadvantages may be cited a reduction in maximum grade over the ordinary water-bound macadam road due to slipperiness of certain surfaces," needs clarification.

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# Beam Tables for Various Materials

Reviewed by A. W. CARPENTER*

SIMPLIFIED FORMULAS AND TABLES for Floors, Joists and Beams; Roofs, Rafters and Purlins—By N. Clifford Ricker, Professor of Architecture, University of Illinois. New York: John Wiley & Sons, Inc. London, England: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. vi + 77; 16 text figures. $1.50, net.

The basis of this book is the consideration of stiffness as a requirement coördinate with strength in the proportioning of beams for certain uses, such as carrying plastered ceilings, and the presentation of the formulas therefor in a "simplified" or labor-reducing form. The "simplifying" of the formulas is accomplished by changing the usual units of pounds and inches to the larger ones of tons and feet, respectively, and supplying the usual values for working fiber stress and modulus of elasticity in place of the symbols for the same. For instance, the usual formula for the section modulus of a beam of uniform section, uniformly loaded, simply supported at ends, is

$$\frac{P\,l}{8\,S}$$

using the author's notation of P = total load in pou[illegible] l = length in inches; S = maximum allowable fiber s[illegible]s in pounds per sq.in.; and for a steel beam with allow[illegible] fiber stress of 16,000 lb. per sq.in., total load 6000 lb., len[illegible] 12.5 ft., the result would be the solution of

$$6000 \times 12.5 \times 12 \div 8 \times 16{,}000$$

and for moment of inertia, to give a deflection (Δ) [illegible] to exceed the length divided by 360, this would be

$$\frac{5\,P\,l^3}{384\,E\,\Delta}, \text{ or } \frac{1800\,P\,l^2}{384\,E}$$

which would require solving

$$1800 \times 6000 \times (12.5 \times 12)^2 \div 384 \times 29{,}000{,}000$$

which is some job, although it can be simplified by [illegible]ting out as a fraction, canceling the common factors in num[illegible]ator and denominator and especially by reducing the fact[illegible]s to decimal fractions of small units, and then using a slid[illegible]rule. By the author's scheme the formulas for section modulus and moment of inertia in the above case and for the same material become

$$\text{Section modulus} = 0.187\ W\ L$$

$$\text{Moment of inertia} = 0.047\ W\ L^2,$$

where W is the total load in tons and L the length in feet, which are unquestionably simpler than the usual formulas, especially for the moment of inertia based on the limiting deflection. The usual formulas for beams variously supported and loaded are similarly transformed and reduced for usual working stresses and moduli of elasticity for steel, cast iron and various kinds of timber, and set forth in various forms in a series of tables which occupy 36 of the 77 pages of the book.

Other tables are furnished, showing moments of inertia and section moduli for rectangular cross-sections, including the usual range of timber beams, and for cast-iron lintels. These tables, together with four pages of logarithm tables (which appear rather useless to the reviewer, who would not think of using anything but a slide-rule for calculation of the formulas) complete the book, except for the explanatory matter which occupies the first 30 pages.

It should be stated that the application of the tables is limited, as the cases of concentrated loading at points other than the free ends of cantilever beams or centers of beams variously supported at both ends are not considered.

The explanatory matter the writer considers open to the severest criticism. It abounds in errors of all kinds, from typographical to those of theory of stress action. These the writer considers so serious that he does not hesitate to state that in his opinion the book is not in proper condition to put into circulation. To cite a few of the errors and evidences of carelessness, the following might be mentioned:

On page 1 the notation of symbols refers to the load as P, while the cuts show p; the bending moment is stated to be given in inch-tons, whereas in this case it is in inch-pounds. On page 6, the symbol L is used, where $L^2$ is correct. On page 10, a list of materials with values for modulus and working fiber stress is given, which list does not contain one of the timbers for which special formulas are furnished in the tables. On page 19, the factor 1.192 in one of the formulas should be 0.047.

On page 16 and in his illustrative examples the author considers a parallel component of load in inclined rafters which he states produces axial compression which should, after being distributed over the cross-section on the basis of an eccentricity of application equal to the deflection of the rafter, be combined with the maximum compressive fiber stress at the center of the span due to bending. The treatment is limited, without any statement to that effect, to the case of a rafter extending over two supports only, the entire resistance to sliding being taken at the lower support. The consideration of the deflection as affecting the axial stress seems trivial in view of the neglect of the manner in which the roof load is applied, viz., continuously along one edge of the rafter, and also in view of the neglect of consideration of many other practical as well as theoretical conditions involved in the case. The writer agrees with the author's conclusion that the axial component may ordinarily be neglected but considers his analysis most incomplete and unsatisfactory.

Perhaps the most glaring error in the book is in the formula on page 18 and its application in the last example in the book on page 30, which considers the case of a purlin on an inclined roof, axis of purlin normal to roof, parallel component of load partly sustained by sag rods. The author considers that the sag rods reduce the span for both parallel and normal components, which is manifestly absurd and gives a serious error. The author also fails to make clear that his general method of determining the stress in a beam with its axis inclined to the plane of the load is correctly applicable only to symmetrical sections, not to such common unsymmetrical sections as Z shapes.

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The presence of so many errors in the text naturally suggests the possibility of errors in the tables which, of course, the writer has not undertaken to check. Even if there were no errors, the writer doubts if such a pretentious publication is warranted. The tables should be of value to designers of buildings involving a great amount of beam work, but any designer could readily prepare similar tables himself. If the tables should be published in condensed form and of a size for attaching to the usual steel-shape handbooks, they would form a valuable adjunct to the latter and their purchase by designers would seem to be more generally warranted.

## Cast-Iron Hooped with Reinforced Concrete

Reviewed by LEON S. MOISSEIFF*

NEUERE BOGENBRUECKEN AUS UMSCHNUERTEM GUSSEISEN—By Dr. Ing. Fritz Edler von Emperger. Paper, 7x10 in.; pp. 152; 200 illustrations. Berlin: Wilhelm Ernst & Son. 5 marks.

The great services rendered to the engineering profession by Dr. v. Emperger by his active interest in the evolution of reinforced concrete as a structural material are known the world over. Twelve years ago Dr. v. Emperger founded the international review "Beton und Eisen" and began to publish it at irregular intervals. Today its popularity is well established, and twenty issues are published yearly. The rise of reinforced concrete and the scientific interest taken in the subject may be considered to date simultaneously with the appearance of "Beton und Eisen." One will find few matters concerning reinforced concrete which have not received their thorough discussion in its pages, and many a fertile idea found there its first expression. It is therefore with a feeling of expectancy that the reviewer took up Dr. v. Emperger's book on "Arch Bridges of Hooped Cast Iron." Nor has he been disappointed.

Few engineers would at the present time look to the use of cast iron as a proper reinforcing material for concrete structures. Dr. v. Emperger studies the behavior of cast iron and its utilization for reinforced concrete. Not only is the application of cast iron recommended and ably defended by the author, but through his efforts an arch of 140 ft. clear span has actually been erected, tested and opened to traffic at the International Building Exhibition at Leipsic.

The author maintains in his preface that the engineering profession has lost during the fifty years reign of steel as a structural material the appreciation of the good qualities of cast iron, in proof of which qualities he quotes a number of cast-iron bridges which have served well during many years. To this may well be added that only those cast-iron bridges survived which possessed the fewest imperfections of this material. The first chapter is, indeed, devoted to short descriptions of English, German, Austrian and French arched bridges of cast iron.

In the succeeding chapter the author, with the aid of a few experiments, discusses the behavior of cast iron reinforced by hooped concrete because in the author's system it is not the iron which reinforces the concrete, but on the contrary the concrete which strengthens the cast iron. Briefly, in reinforced cast iron the function of the hooped material is to maintain the hooped concrete in an elastic state and that of the concrete is to maintain the surface of the brittle metal under the hooping pressure and thus eliminate its brittleness. The duty of the hooping material is not to increase the resistance of the embedded cast iron, but to make it more reliable by protecting it against brittleness. The hooping may, therefore, be made so much lighter than for the usual hooped concrete. It must, however, be dense enough to insure a perfect envelope to the cast iron.

The author recommends the spacing of hooping wires to be not less than the thickness of the hooped concrete envelope. For this arrangement, the author claims, the ultimate resistance of a compression member of hooped cast iron may be taken as equal to the sum of the resistances of the individual parts with a proper allowance for column flexure, and he recommends a factor of safety of four. It should be here added that the author expects to get a cast iron with a compressive resistance of at least 100,000 lb. per sq.in. and frequently one reaching 140,000 lb.

The author then proceeds to discuss the column resistance of hooped cast iron by the aid of a few ingeniously devised tests. The results obtained are remarkable and should a series of exhaustive tests affirm the uniformity of these results hooped cast iron will soon be added to the favorite materials of the modern engineer.

The book further contains a full and well illustrated description and the detailed computations of the Schwarzenberg Bridge, built as mentioned in the above, at Leipsic, Germany, on the occasion of the International Building Exhibition of 1913. The bridge consists of a single arch of about 140 ft. clear span and 18-ft. width. It is built for foot passengers and designed for 102.5 lb. per sq.ft. (500 kg. $m^2$). The reinforced-concrete floor is supported by posts on two arched ribs of hooped cast iron, braced by concrete struts. The cast iron used developed on specimen tests an average ultimate compressive resistance of 123,000 lb. per sq.in., and an allowable unit stress of 24,200 lb. was assumed and approved by the building authorities. The contractor had at first some difficulty to obtain a cast iron of such high strength. The reinforcing consists of two cast-iron channels for compressive stresses and steel rods for tensile stresses. The bridge, as it appears on the photographic views, possesses an excellent appearance and shows strength as well as grace in its outlines.

The book is well illustrated, and in every way of good makeup, and it is to be regretted that many of the text references to the illustrations are wrongly numbered, making identification difficult.

Dr. v. Emperger deserves credit for calling the attention of the engineering profession to his efforts and achievements in the direction of hooped cast iron. The renascence of cast iron is a matter of great interest to structural engineers.

*Engineer of Design, Department of Bridges, New York City.

## Wire-Cable Suspension Bridges

Reviewed by LEON S. MOISSEIFF*

DAS KABEL IM BRUECKENBAU—By Dr. Ing. F. Hohlfeld. Paper; 6x9 in.; pp. iv + 119; 69 illustrations. Berlin: Julius Springer. 4 Marks.

Dr. Hohlfeld's study of the application of wire for suspension bridges was evidently prompted by recent developments in Germany. The increase in population and wealth of the larger German towns and the growing importance of their shipping has brought problems of long-span bridges to the attention of the municipal authorities and directed the German bridge engineers toward the best solutions of these problems.

Particularly the bridge over the Rhine, at Cologne, attracted recently the interest of German bridge builders. Competitive designs were called for this bridge in 1910 and the results pointed to the great esthetic advantages of the suspension type. A suspension bridge was indeed adopted by the municipal authorities. Five of the original competitors were invited to submit designs together with bids for the construction of a suspension bridge in accordance with given specifications. It is much to be regretted that the deflections specified were so limited as to prevent the utilization of the full strength of wire cables and, consequently, also of the economic advantages of wire-cable bridges. In other words, the allowable unit-stress on wire in cables would result (with the specified dimensions) in a deflection exceeding the one prescribed, and a lower unit-stress had to be used therefore. As the bridge is intended for a pair of trolley tracks and ordinary highway traffic, the limitation as to deflection was unnecessarily rigid. At any rate, the interest taken in this bridge by German bridge builders caused at least two firms to apply to American engineers for advice as to American methods of suspension-bridge building. But the above limitations to the economical efficiency of wire-cable bridges have led to the adoption by the municipality of a suspension-bridge design with the main tension member built of bars or plates.

The interest taken has brought forth several studies of problems affecting long-span bridges by German engineers. One of these, evidently, is Dr. Hohlfeld's book on "Wire Cables for Bridges." It is almost evenly divided into two parts; the first treats of the historical development, manufacture, erection and qualities of cables for bridges, the second discusses their possibilities.

The manufacture of cables is discussed by the author. Cables made of twisted wire ropes, locked cables of the German and French types and cables made of parallel wires laid in place as in the construction of our great American suspension bridges receive due consideration. Tests of elongations under stress of locked cables are quoted and some interesting information as to volume, weight and ultimate resistance of German locked cables is supplied. The evolution of the American method of erecting cables of parallel wires is traced from the French engineers, Seguin and Vicat, in the

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early part of the last century, to the Brooklyn, Williamsburg and Manhattan bridges over the East River.

As far as Europe is concerned, the author must content himself with a number of designs of cables and their attachments for suspension bridges proposed for Budapest, Bonn and Cologne. Here appear parallel-wire cables as well as cables consisting of single-wire ropes or strands laid with a clear space between each other to permit of the substitution and renewal of the individual strands, if required. The illustrations show some clever solutions of the difficulties encountered. Especially noticeable are the efforts to obtain a uniform distribution of the stress in the separate strands.

The same desire to obtain at each panel-point a statically determined, definite distribution of load from the hangers to the individual cables dominates the second half of Dr. Hohlfeld's study of the possibilities of cable design. He analyzes various solutions and produces the detail design of a panel-point connection consisting of a multiplicity of lever arms, compactly arranged and ingeniously devised, for a panel load of 440 tons and a cable of about 70,000 tons ultimate resistance.

It is doubtful whether all this effort to secure statical determinateness is of any real value in meeting structural needs. Movable parts requiring the adjustments of machines of precision most frequently refuse to work under the heavy strains of bridge loads. Interesting as the author's studies are he would have enhanced their value if he had given more weight to facts and less to schemes.

The author arrives at the conclusion that the advantages of cables of parallel wires will secure for them the field and extend suspension-bridge building.

A short but complete bibliography of the subject treated precedes the text.

The little book is a good compilation of widely spread information well brought together, and will prove full of interest to the designing engineer who grapples with the many-sided problem of suspension bridges.

## The Design of Transmission Systems

Reviewed by C. D. GRAY*

OVERHEAD ELECTRIC POWER TRANSMISSION: Principles and Calculations—By Alfred Still, Assistant Professor of Electrical Engineering, Purdue University; author of "Alternating Currents and the Theory of Transformers" and "Polyphase Currents." New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 310; 110 text figures. $3, net.

This book seems to fill a vacant plac in the literature on the art of power transmission, and is neither too technical nor on the other hand too elementary for the average engineer who has problems of this kind to solve. It is a complement to "Transmission Line Construction," by R. A. Lundquist, issued by the same publishers last year, which treated the subject from the field-construction man's point of view, showing methods and costs of construction. The present volume treats the subject more particularly from the point of view of the office engineer who is called upon to calculate and design transmission systems.

While the subject matter in the book is good, still there are some statements that might be qustioned by the practical electrical engineer, such as the use of horsepower instead of kilowatts on pages 48, 50 and 51. It would seem that the use of the electrical units would be better from an electrical engineer's standpoint and would be more in keeping with the advance in the art, which seems to be to use the kilowatt instead of horsepower as the unit for power measurements.

A few more practical examples illustrating the use of the various formulas would be advisable, as such examples are often quite essential, especially when the book is used by engineers who seldom have occasion to solve problems of this kind.

The author's discussion of the Thury direct-current system is the best that the reviewer has seen and is very properly included in this book.

The author very wisely uses the parabolic formula for sag calculations instead of the much more complicated catenary formula used by many writers but, in common with all other writers on the subject of sag calculations, he makes use of the usual moduli of elasticity for various materials and does not consider the fact that when cables are made up of several strands of small wires there is an elongation under stress, due to the stranding, which is not uniform and is not in accordance with the usual moduli, but varies with the number of strands, the lay of the strands, hardness of the material, manner in which cable is made up, etc. The ratio of stress to extension can only be determined by actual tests on samples of the completed cable which is to be used ; it is necessary that such tests be had before any careful cal- culations can be made, if accurate results are desire which is only necessary on spans of 750 ft. or over. In this apter it would also seem that some reference should ha been made to the calculated sag when suspension insula s are used and careful sagging is necessary to maintain a rtain minimum clearance to the ground under all conditio This clearance is greatly diminished in any particular spa when a wire breaks in the adjacent span, due to the fact t the length of the suspension insulator unit is added to th ngth of wire in the span under question, thus allowing the re to sag closer to the ground.

In the chapter on transmission line supports (pag 266), is the statement: "It is now generally recognized that there are advantages in having transmission-line support with flexible or elastic properties." This statement would be challenged by many transmission-line engineers. The further statement and inference that a line built of such flexible or semiflexible construction is much cheaper than the rigid construction may not be borne out in practice. There is also a doubt as to whether some of the advantages claimed by the author for this type of construction are substantiated by actual experience.

Several of the appendices seem to be uncalled for, but some are pertinent and good. Appendix F, which is a sample specification for short-span line construction, seems to be too detailed and elaborate for this character of work, especially in regard to such matters as the stringing of wires. In fact the most of this specification could have been covered by referring to the specifications contained in the report of the Overhead Committee of the National Electric Light Association, which is being used as standard by many companies. Suitable modifications, of course, would have to be made to adapt it to high voltages, but in the main it could be used and its use would be in the line of standardization. In the same connection reference might well have been made to the specifications for railroad crossings prepared by the joint committee of the National Electric Light Association, the American Institute of Electrical Engineers, the American Railway Association and others.

In Appendix "G," covering specifications for steel-tower lines, it would seem better practice to have separate specifications for towers, insulators, hardware and conductors and one covering the layng out and construction of the line for the use of the field force.

In general, the subject matter of the book is good, well arranged, and with the exception of the points mentioned above, some of which are minor, the work is a valuable addition to the literature on electric power transmission.

## Diesel's Story of His Engine

Reviewed by WINSLOW H. HERSCHEL*

DIE ENTSTEHUNG DES DIESELMOTORS—By Rudolf Diesel, Dr. Ing. H. C., Der Technischen Hochschule München. Berlin: Julius Springer. Paper; 8x11 in.; pp. 158; 83 text illustrations, 3 folding diagrams. 5 Marks.

As a student in Munich in 1878, the late Rudolf Diesel, the inventor of the Diesel engine, heard Prof. Linde state that the thermal efficiency of steam engines was from 6 to 10%, and he resolved then and there to investigate the possibility of attaining isothermal expansion and consequently higher efficiency in a practical machine.

His first experiments were with superheated steam, but by 1893 he had transferred his attention to processes of combustion and published his book on the theory of a rational heat engine. It was due to the favorable reception of this book by Professors Linde, Schröter and Zeuner, that Diesel was able to make an agreement with the Maschinenfabrik Augsburg and Fried. Krupp to build an experimental engine. Then came four years of experiment. The first engine did not develop enough power to run itself. The automatic ignition was successful, but this had been attained by others and is not the chief characteristic of the Diesel engine. This is rather the high pressure, 30 to 35 atmospheres, which is necessary for high efficiency, a much lower pressure being sufficient for automatic ignition. The second engine gave some good diagrams, but they could not be obtained continuously. The third series of experiments, which lasted six months without result, was the most discouraging, but from then on, progress was fairly constant, and at last in February, 1897, the official test of Prof. Schröter showed a thermal efficiency of 26.2%. After the Diesel engine had thus been proved superior to any competitors, plans were made for putting it upon the market, but experiments were continued

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in regard to details of construction, with various kinds of fuel, including pulverized coal.

Throughout the book, Dr. Diesel relates with equal frankness the details of his failures and of his successes, and the former are as instructive as the latter. He has given us a most interesting example of how an idea, correct in theory, may be brought by perseverance to a successful practical application. It may well serve as an inspiration to any inventor struggling with difficulties.

## A German Text on Machine Design

Reviewed by WINSLOW H. HERSCHEL*

LEHRBUCH DES MASCHINENBAUES—Herausgegeben von Karl Esselborn. Zweiter Band: Dynamomaschinen und Elektromotoren; Hebemaschinen; Baumaschinen; Wasserkraftanlagen; Bearbeitungsmaschinen. Leipzig and Berlin: Wilhelm Engelmann. Paper; 8x11 in.; pp. xvi + 671; 1028 illustrations. 30 Marks.

The first volume of this textbook of machine design was published two years ago and was briefly noticed in these pages on June 15, 1911, the work being now complete with the second volume. Though somewhat encyclopedic in style, limitations of space required the omission of many common types of machinery used in marine engineering, railroading and refrigeration, while hydraulic machinery is represented only by turbines.

The first and longest section, that on generators and motors, is based on the German standard frequency of 50 cycles, and this decreases its value to American readers. Stationary hoists and cranes take up so much of the next section that there is but little space left for electric traveling cranes and locomotive cranes, and passenger and freight elevators are not considered at all.

It would be difficult to find in an American book such an extensive treatment of excavators, pile drivers and concrete mixers, but on the other hand there is little in regard to conveyors.

Selecting the site for a hydraulic power plant and laying out the power house both influence, to such a great extent, the design of the turbines, that it is appropriate that considerable space should be devoted to these matters which at first sight appear to concern the civil engineer rather than the machine designer. But in the present instance this has the unfortunate result of leaving an entirely inadequate amount of space for the consideration of turbines, and only two pages for Pelton wheels. In the section on machine tools many of the illustrations are from photographic views of complete machines which show very little, but there are also a number of sectional views which show more clearly the interior mechanism of the machines. The work could be improved as a textbook by having more examples worked out in the text and problems placed at the end of chapters.

## The Blading of Steam Turbines

Reviewed by WINSLOW H. HERSCHEL*

DER WIRKUNGSGRAD VON DAMPFTURBINEN-BESCHAUFLUNGEN—By Paul Wagner, Oberingenieur in Berlin. Berlin: Julius Springer. Paper; 7x10 in.; pp. viii + 129; 107 text figures. 6 Marks (Bound, 6.8 Marks).

The efficiency of steam turbines, with a given quality of steam, is determined almost entirely by the blading, since mechanical losses are very slight. In spite of the fact that nozzles are never made in the theoretically correct trumpet form, the loss of velocity in the nozzle is usually not overy 5% or at most 10% for very high drops of pressure. The nozzle loss is thus small compared with the loss in the blading. Information concerning nozzle loss may be readily found elsewhere, and therefore the author has devoted his entire attention to the efficiency of the blading.

The book is not intended as a textbook, but as a help to designing engineers, and for this reason all discussion is confined to axial flow turbines, to which type the great majority of practical turbines belong. The most successful radial flow turbine, thus excluded, is perhaps the Elektra.

Turbines of the Curtis type are considered in the first 44 pages of the book, and the remaining space is devoted to multistage turbines without velocity stages, three types being considered. The first is the pure pressure or Rateau type, the second is the Parsons turbine where approximately half the available pressure per stage is transformed into velocity in the stationary blades, and the third is the pure reaction type which the author shows may be used without loss of efficiency. The book is the result of the author's long experience as a turbine designer and should prove useful to others in showing the relative advantages of the different types of turbines. At the end, is a total heat-entropy diagram, about 16 by 23 in. in size, calculated from the latest determinations of the value of $c_p$.

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## Industrial Illumination

FACTORY LIGHTING—By Clarence E. Clewell. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. vii + 161; 100 text illustrations. $2 net.

The author's peculiar experience, though perhaps not as great in point of years as that of a few other illumination specialists, has fitted him to speak most convincingly on industrial plant lighting. He shows, moreover, a keen appreciation of the difficulties of applying intricate theoretical methods of design under conditions which are universally unfavorable to accurate analysis, and he very sensibly falls back on engineering experience in arranging satisfactory illumination schemes. Indeed he does not even go far in generalizing this experience into broad rules of practice, but rather contents himself with citing actual typical installations, covering shops and offices fairly well, with advice to the reader to study what has proved satisfactory under the conditions outlined and to see therefrom how any proposed installation should properly be worked out.

It is unfortunate for such a useful book that the rapid improvement of light sources must make it a little out of date before it has secured its merited circulation. The recent development of the half-watt tungsten lamps in very large candlepower units gives an illuminant of great importance in factory work. Naturally the ordinary engineering reader, untrained in illumination problems and unadvised of the different characteristics of the new lamps compared with older high-candle power units, cannot know how to make a good substitution. It can only be hoped that the first edition of the book is not so large but that some addition may soon be made by the author in a new printing after the latest tungsten lamps become more widely used.

The book starts out with such axioms as the need of sufficient illumination, uniform distribution, lack of glare and rapid fluctuations, etc. He makes a very brief comparison of the lighting units which have been used in factory practice and then plunges into the design of illumination. Here is the closest approach to general rules of practice. The author urges careful inspection of location to see the effect of construction. He cites some of the conditions which affect the type and size of lamps, the spacing and height, the selection of reflectors and globes, the arrangement of circuits for switching control. He shows a very simple scheme for computing the total illumination at any point with a given tentative spacing and height of lamps, based on the simple laws of light distribution. After this is a chapter on installation work, giving very largely practical points which need to be watched for satisfactory and economical results. There is a chapter on lighting maintenance and maintenance records. He shows here the economy of systematic care of lamps and the great returns brought by comparatively small expense for this work.

So far a little less than half of the book has been covered. The rest of the volume is taken up with what we might call the citations of specific installations already noted. These fall under lighting for offices, drafting rooms, ordinary factory buildings, power houses, iron and steel mills, foundries, etc. There is appended finally some notes on machine-tool lighting, where, if ever, it is essential to stick to the use of individual lamps on account of the necessity of throwing light in directions impossible with overhead installations. This chapter shows how glare, eye strain, and all the other evils of individual lamps may be mitigated.

TELEPHONE CABLES—A Handbook of the Design, Construction and Maintenance of the Telephone Cable Plant. By J. C. Slippy. Pittsburgh, Penn.: The Author, 428 Oliver Bldg. Cloth; 4x7 in.; pp. xviii + 147; 97 text illustrations. $2.50, net.

In a handy little book, the author presents mostly descriptive matter and data. While the book has a broad title, no attempt seems to have been made to present some features of telephone cable plants about the country—such as interior and submarine cables, loading devices, etc. There are specifications for the more common cables, an outline of the service design of cable plant, descriptions of cable-line construction details (occupying nearly half the book), a discussion of the utility of service records in promoting best use of plant, descriptions of methods of inspection for electrolysis, current in sheaths, and troubles generally, methods of locating faults and making repairs. At the end are tables of miscellaneous unit costs, physical properties, etc.

# A German Standard Work on Heating and Ventilation

Reviewed by JOSEPH HERZSTEIN*

LEITFADEN ZUM BERECHNEN UND ENTWERFEN VON LUFTUNGS- UND HEIZUNGS- ANLAGEN — Ein Hand- und Lehrbuch für Ingenieure und Architekten. By H. Reitschel, Geheimer Regierungsrat und Professor, and K. Brabbee, Professor an der Kgl. Technischen Hochschule zu Berlin. Two volumes. Fifth edition. Berlin, Germany: Julius Springer. Cloth; 6x9 in. Vol. I. pp. xv + 524; 84 text figures. Vol. II, pp. vi + 159; numerous drawings and diagrams. 28 Marks.

The awakening interest in the more scientific aspects of heating and ventilation in the United States should make peculiarly welcome the fifth edition of this work which represents the fruits of Dr. Rietschel's long connection with the experiment station for heating and ventilation at the Technische Hochschule of Berlin. His book, which for twenty years has been a standard in Germany, is a practical working manual for heating and ventilating engineers. In purpose, scope and treatment it is similar to the American books, Carpenter's "Heating and Ventilating Buildings," and Hoffman & Raber's "Handbook," but is much more complete and the technical problems are given more liberal mathematical treatment.

Volume I devotes six chapters to ventilation and fourteen to heating. In the first four chapters, the properties of air, necessity of air change, air vitiation, magnitude of air supply with temperature, humidity and carbon dioxide as bases are discussed. These chapters have been extensively re-written (by the senior author) in the present edition and it is interesting to note that ventilation constants are based primarily on the need for temperature conditioning and only secondarily and in certain specified cases on carbon dioxide dilution. Chapters 5 and 6 (100 pp.) deal with the arrangement of parts of ventilating plants, air washing, air humidification, air drying and in more detail with the design of ducts and with means for the propulsion of air, together with calculations and discussions on the design of ventilating plants, the establishment of requirements and the choice of systems, with 23 hp. of illustrative examples.

Chapters 7, 8, 9 cover the formation and utilization of heat, grates, heat losses, heat constants, heaters and their arrangement. Chapter 10 briefly discusses local stove, furnace and gas heating. Chapter 11 (85 pp.) is given over to a thorough treatment of hot-water heating, covering the arrangements of the system with ample calculations for dimensions of boilers, heaters and piping for several types of systems which include the one- and two-pipe gravity system, quickcircuit heating and forced circulation heating. This section has been rewritten by Dr. Brabbée and contains much new material. The French calorifére system of hot water heating with a blind-end pipe, and high- and low-pressure steam heating are treated in chapters 12, 13 and 14. For all of these systems the arrangement of parts, boilers, heaters and piping are discussed and detailed calculations are given. Hot-air heating is treated with the same thoroughness as is also the subject of cooling. Guides for drawing up and checking heating and ventilating plans and helpful suggestions drawn from the author's long experience add greatly to the practical value of the book.

Volume II is devoted to tables and illustrations. The tables generally found in such hand-books are here given, including physical properties of air at different temperatures, heat quantities for cooling and warming of air, air velocities in conduits, radiation, conductivity, and heat transmission coefficients but with more completeness than is usual. A table on an hourly air change for a room temperature of 20° to 23° in order not to overstep a 70% humidity and a table on the amount of water necessary to saturate outside air (from —20° to +5°, with 70%, 80%, 90% saturation) to room temperatures of 10° to 25° with 50% saturation is an indication of the growing importance of the general problem of humidification. Especially good tables are those on heat convection giving the hourly heat quantity yielded by 1 sq.m. of heat surface from water, steam and air heat to air, the air in one case possessing only natural motion and in the second case a definite, given velocity (10 pp.) and the tables on frictions and resistances and water velocities in pipes (60 pp.) besides the tables for determination of pipe dimensions for high and low pressure heating systems.

The parts used in practical systems of heating and ventilating are well represented in over 250 clear, diagrammatic drawings. A discussion in detail of the usefulness of the different types of apparatus might have been of value in connection with these figures.

Drs. Rietschel and Brabbée have produced a work typically Teutonic in thoroughness and mastery of elementary principles. Their handling of the material is good, the theoretical and practical considerations being well balanced and intimately connected, the language is clear and simple. The tables are unique in scope and completeness and the work should prove of great value to American engineers.

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# Irrigation Canals

Reviewed by F. W. HANNA*

IRRIGATION WORKS: The Principles on Which Their Design and Working Should be Based, with Special Details Relating to Indian Canals and Some Proposed Improvements—By E. S. Bellasis, M. Inst. C. E., Recently Superintending Engineer in the Irrigation Branch of Public Works, Department of India. London, England: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 5x8 in.; pp. 195; 37 illustrations and text figures; $2.50, net.

Under the title of "Irrigation Works" assigned by the author of this book, one might reasonably expect a comprehensive, technical treatment of the whole field of the construction and operation of irrigation works. The author has, however, treated but a small portion of this field, having limited his discussion principally to features of canal design and operation. The title is, therefore, too broad and likely to be misleading.

The book containing five chapters comprising 168 pages and nine appendices of 27 additional pages. After the introductory chapter the author discusses the designing of canals, their operation, the Punjab Tripple Canal Project and improvements in irrigation canals. The various appendices treat of escapes, gages, modules and minor miscellaneous matters relating to canal maintenance. The principle value of the book lies in the second and third chapters, treating of canal design and operation.

The author's discussion of distributing canals is worthy of careful consideration as it covers some important principles in the design and layout of distributaries sometimes overlooked or poorly executed. Illustrative of the character of points made by the author are his suggestions to carry the distributaries high enough to command the irrigable area when they are carrying three-fourths supply; to place distributary outlets at grade and to use wood for their preliminary construction; to allow fall for measurement of water at the outlets, for grade in the watercourses from the outlets to the irrigable land and for getting the water from the watercourses to the land. These suggestions are more or less obvious and commonplace, but they are points sometimes overlooked in field practice and generally overlooked in works on irrigation.

Constant reference is made in the text to the author's "River and Canal Engineering," a copy of which is essential to a good understanding of the book under review. The subjects of the two books are intimately related and it is to be regretted that the author did not treat them in a single volume.

The work is written in good, plain English, but contains a number of typographical errors. Much of the subject matter is commonplace and none of it is technical. The whole work smacks of the man in the field familiar with the difficulties of both construction and operation of irrigation works; and it is refreshing to read a book of this kind after reading the writings of observers and compilers who are not so intimately acquainted with the details of the construction and operation of such works. While the book is not a technical treatise or a large storehouse of information on irrigation, yet it contains valuable principles and facts relating to irrigation and is worth reading.

THE GAS-ENGINE HANDBOOK: A Manual of Useful Information for the Designer and the Engineer—By E. W. Roberts, author of the "Automobile Pocketbook" and other works on Gas Engineering. Seventh edition, entirely rewritten and enlarged. Cincinnati, Ohio: The Gas Engine Publishing Co. Leather (flexible); 4x7 in.; pp. 323; 85 text illustrations. $2.

The first issue of this handbook appeared in 1900, and it is a good illustration on the active development of the internal-combustion engine since that time that the present volume appears as the seventh edition and the tenth thousand. The book has been rewritten and enlarged materially since its first issue, the present edition particularly having been radically revised. The convenient pocketbook form, however, is still preserved.

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As the author frankly states in his preface, the book is not intended to be a complete treatise like the monumental work of Guldner, for example; but is designed as a handy book of reference, for the use of engineers interested in this branch of work. It is, of course, impossible within the limits of such a book as this to go into any detail regarding special types of motors, and while the author has attempted to discuss very briefly automobile engines, marine engines, aëronautical motors, etc., the more valuable portion of his book is that which relates to the design of various engine details and to operation, testing, etc. We believe the book well deserves the success it has attained.

## An Unusual Book

Reviewed by H. E. LONGWELL*

HYDRAULIC TURBINES; With a Chapter on Centrifugal Pumps—By R. L. Daugherty, Assistant Professor in Sibley College, Cornell University. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. ix + 151; 96 text figures. $2, net.

A real treat. A book written solely in the interest of the reader and without any evidence of an effort on the part of the author to make a spectacular display of his own erudition and industry.

It is a little book, and it exemplifies in a striking manner how small a book is required for covering the essentials of a large subject, provided the author is willing to give the reader credit for possessing reasonable intelligence, and the rudiments of a technical education.

The author classifies and describes briefly the several types of turbines and settings. There is a chapter on water power in general, touching on the questions of preliminary survey, stream gaging, storage and kindred matters. The next two chapters are devoted to a detailed description of impulse and reaction turbines. Then follow three chapters of a neat and concise presentation of the theory of hydraulic turbines. If the reader does not care to trouble himself with this mathematical work—which is by no means abstruse—he can still read the remainder of the book understandingly, and with profit to himself.

The subject of turbine testing is treated briefly and sensibly. Then follows a chapter on the general laws and constants, by which turbines of various designs may be compared. Two chapters are devoted to the question of the selection of turbines with reference to the conditions under which they must operate. The chapter on the cost of turbines and water power is interesting and instructive.

The book concludes with a chapter on centrifugal pumps, which is purely theoretical and the relevance of which is not very apparent, except for the fact that a centrifugal pump is a reaction turbine running backward.

This is not a book for the few specialists in hydraulic engineering, but for the many general engineers to whom just such a concise, yet comprehensive presentation of the subject, will be useful. Those who have to do with the operation or supervision of water power plants, and the purchasing of equipment for such plants will find it especially helpful. It is also an excellent elementary text book for students.

The treatment of the subject is very brief, but if the reader desires elaboration on any of the points, he will find plenty of foot-notes and other references directing him to the proper sources.

The style is clear and pleasing, and the work as a whole is a most refreshing and commendable bit of engineering literature.

CONSERVATION OF WATER—By Walter McCulloh, C. E. [Addresses Delivered in the Chester S. Lyman Lecture Series, 1912, Before the Senior Class of the Sheffield Scientific School, Yale University.] New Haven, Conn.: Yale University Press. Cloth; 7x10 in.; pp. x + 99; numerous plates. $2.50, net.

Mr. McCulloh's book is a reprint of a series of lectures delivered at Yale College under the auspices of the Chester S. Lyman Lectureship Fund, the income of which is to be devoted to the maintenance of a course of lectures on Water Storage Conservation. As the first of the lecture courses on this subject, the present ones admirably present a broad view of the whole field of water conservation, suitable alike to student and practitioner, although naturally the former was primarily in the mind of the author in the preparation of his work.

The first lecture is devoted to the general subject of conservation and its relation to water resources. The author states that the principal problems to be solved in the study of water conservation are: (a) Can the flow of rivers be regulated and floods prevented; and (b), if so, by whom and through what instrumentality shall the control and regulation be effected?

The first question is answered in the affirmative, after a brief reference to the obvious necessity for such work. The second is divided into two answers relating to the physical means of conservation and its political control, respectively. Mr. McCulloh is opposed to the forest development theory of flood control, although he admits the desirability of forest increase for other purposes, and puts all his reliance in the construction of storage reservoirs, which he says, "is the most effective and the only practical method of controlling the flood waters and increasing the flow of streams during the summer droughts." As to the question of political control he is vague, voicing only the known difficulties connected with the conflicting political interests claiming jurisdiction over running waters in the United States.

The second lecture is devoted to "Basic Data Essential to a Comprehensive Study of Water Storage" and is a brief but complete statement of the preliminary engineering operations requisite for water storage work. It divides the operations into economic, hydrographic, topographic and geologic and treats each in turn.

Lecture three takes up water-power development and traces the necessary steps in the study and planning for such plants in general and a typical plant in particular. Lecture four, on the storage of water for the direct uses of the people, i.e., for water-supply sanitation and irrigation, is especially directed toward the necessity for the methods of saving water for its rational use, rather than toward the engineering features of constructions for these purposes.

The last lecture specifically relates the progress of water conservation in the State of New York, and describes in detail a number of water-power developments on the rivers of that State.

## Rules for Managing a Shop

Reviewed by R. R. POTTER*

RULES OF MANAGEMENT. With Practical Instructions on Machine Building—By William Lodge, President of the Lodge & Shipley Machine Tool Co. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. xiii + 139. $2, net.

The author's foreword describes this book as a record of personal experience put in the form of rules and comment. It was written primarily to give information to the succeeding manager of the shops of the Lodge & Shipley Machine Tool Co. In this record, the duties and work in each department are outlined in some detail. This extends from the general manager of the shop down to janitors and watchmen. It will be seen therefore that this book deals not at all with the theory of management. It is simply a manual of rules and instructions for the several officials of a certain organization. A truer title would be "Rules of Management of the Lodge & Shipley Machine Tool Co." The point that should be emphasized is that this book does not discuss the reasons for the organization in the given form nor does it even present a description of the organization itself as such. It simply takes for granted the system of management as it exists and sets forth the duties of the various officials.

Two exceptions to the above general statement should be noted: first, the chapters on the cost and time-keeping departments and the one immediately following on the premium plan (comprising together only four pages); second, the last two chapters of the book, which describe a proposed system of pensions. Throughout the book, the statement of rules and duties is mingled with pithy remarks and suggestions which make the book almost as valuable as a personal talk with the author. Some of the chapters, like the one on the "Forge Department," consist either entirely or almost entirely of practical instructions on the technical features of the work itself.

It is clear then that Mr. Lodge's book is a record of personal experience, as he himself puts it, rather than a study of management in the abstract. It relates chiefly to personal problems rather than to any system of management. A brief outline of the scheme of management as a whole, or at least a chart showing the flow of authority, would be a most interesting addition to the book. As nearly as can be learned from the text as it stands, the system of the Lodge & Shipley plant belongs to what Mr. Gilbreth would call the traditional type of management, improved by the adoption of modern time-keeping and cost-keeping methods and a premium plan.

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# Steam Power Plants

STEAM POWER PLANT ENGINEERING—By G. F. Gebhardt, Professor of Mechanical Engineering, Armour Institute of Technology. Fourth edition, rewritten and reset. New York: John Wiley & Sons, Inc. London, England: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xvi+989; 609 text illustrations. $4, net.

The first edition of Professor Gebhardt's text was reviewed at length in "Engineering News," Nov. 12, 1908, its encyclopedic treatment from coal pile to flywheel being outlined. The whole work then seemed modern, comprehensive and reliable but, of course, the art has not stood still. Professor Gebhardt has shown commendable industry and carefulness in preserving the characteristics of the first edition. Many of the illustrations are improved in technique. The more prominent changes seen are briefly noted in what follows. In only a few cases can further improvement be suggested at this time.

The treatment of fuels is amplified, giving also what was lacking in the first edition—comprehensive tables of analyses of typical coals. There are several new pages of data on boiler trials and more on boiler settings and apparatus for smokeless combustion.

Under steam engines, the Carnot and Rankine ideal cycles are compared more at length and use of the latter is shown further. There is more on engine losses and efficiency and new drawings of notable types. Under steam turbines, the various types are less dogmatically classified. The author here still persists in stating that Curtis turbines, of over 9000 kw. capacity, are of vertical-shaft design, whereas it has been known for a year or more that the horizontal type was to supplant it. Strangely, too, the author carelessly groups with turbines a much advertised small rotary engine, accepting the publicity men's statements that it works by impulse as well as by pressure.

The theoretical discussion of condensers is enlarged and there are descriptions of some of the new rotary-jet condensers, though silent on certain other examples of this development. These pieces of apparatus have been designed to secure high vacua economically and great claims have been made. It is admittedly difficult to secure accurate commercial test data, but if such could have been printed here or under pumps, they would have enhanced the value of the text. There are few changes in matter on feed-water heaters and purifiers; nothing has been added, as there might have been, on recording hotwells and metering heaters.

Several pages have been almost wasted under pipes and fittings on the so called "Manufacturers 1912 Standard" and the "U. S. 1912 Standard" (of the American Society of Mechanical Engineers). Both of these have been superseded, as might have been foreseen, by a compromise to be called the "American 1914 Standard." Among the important additions is a diagram for the easy calculation of pipe sizes, steam velocities and discharges.

The section on lubrication is little changed. It is to be regretted that the author did not see fit to record the use of graphite in oils, especially the use of colloidal graphite and the formation of "graphitoid" supporting surfaces on bearings.

Under testing and measuring equipment, automatic water weighers and orifice meters have been added and much more is said of steam meters of the pitot-tube type which were lightly touched on in the first edition.

The section on finance and economics has been increased by a discussion of the plant records it is well to keep, and many blank forms for reports are given. The data on depreciation have been greatly increased, but without perhaps equally increased warnings of caution as to their use. The author would have done well had he noted that the best practice today uses such life tables only as a basis of departure after examination. Later figures on cost of power have been substituted for older ones and a few words are seen on the effect of load characteristics upon plant design.

The Fisk St. station in Chicago is described and drawings are reproduced, to show a typical large central electric station. However, nothing is said here about the enormous (20,000- and 25,000-kw.) horizontal steam-turbine units being installed instead of extending with the smaller vertical types described. A 1000-kw. station in Manchester, N. H., is described in place of a 1200-kw. plant in West Albany, N. Y., as typical of isolated plants.

The appendices in this fourth edition show considerable growth since the first printing. Running over them briefly, these are the Am. Soc. M. E. 1912 codes for general power plant or device testing, for boiler trials, reciprocating engines, complete steam plants and for pumping machinery, besides tables of the properties of saturated steam, common mechanical and electrical unit equivalents and conversion factors, and a Mollier diagram (total heat-entropy chart). In the first edition the appendices gave codes for [illegible] engine trials, steam tables, units, factors, etc. The [illegible] eral bibliography (Appendex A) has now been [illegible] the special lists of references after each [illegible] have been cut down very much.

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FARM GAS ENGINES—By C. F. Hirshfeld, Professor of Power Engineering, and T. C. Ulbricht, Instructor in Department of Power Engineering; Sibley College, Cornell University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. [illegible]239; 188 text illustrations. $1.50 (6/6) net.

According to the preface of this book, the authors have written it to serve as a guide to farmers contemplating the purchase of a farm engine. The book they have written is an excellent elementary treatise on the design and construction of small sizes of internal-combustion engines, intended for farm use; but we doubt very much whether the average farmer or even the exceptional farmer will buy such a book and make practical use of it in the purchase of an engine.

This is not the fault of the authors. It simply is the result of conditions. The average man or the average farmer has only a smattering of knowledge concerning the machines which he buys and uses. He buys sewing machines, or typewriters, or automobiles, or gas engines chiefly on the representations of the manufacturers and the salesmen as to what the machine will do; and he will not spend the study necessary to purchase such machinery with expert knowledge even though books upon its design were supplied to him gratis. For that matter, almost the same thing may be said of engineers, unless they happen to have given special study to or done special work in connection with the particular line of machinery concerned. Very few civil engineers—and not too many mechanical engineers for that matter—are thoroughly posted on the details of the design of even such common machines as automobiles, road rollers or steam engines.

While we do not believe that farmers will be extensive purchasers and readers of this book, it may nevertheless find a large field of usefulness. Every country repair shop nowadays must be prepared to repair farm gas engines, and the mechanics engaged on this work are very apt to perform it with none too much intelligence and skill. Among the boys coming up on the farm, too, there is always a certain proportion with a mechanical turn of mind to whom such a book as this will be a veritable treasure. It may not only teach them how to properly take care of any engines under their charge, but may give them a start toward systematic study of mechanics and engineering such as Forney's original "Catechism of the Locomotive" gave to hundreds of boys some thirty years ago. Besides the above, the mechanics employed in the works which construct the various types of farm engines, will many of them profit by the study of such a book as this; and it will make, we judge, an excellent book for the classes in farm machinery which are carried on in the agricultural colleges.

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AMERICAN IRRIGATION FARMING—By W. H. Olin, Director of Agricultural Extension, University of Idaho. Chicago, Ill.: A. C. McClurg & Co. Cloth; 5x8 in.; pp. 364; illustrated. $1.50, net.

The author has produced what appears to be a very satisfactory book "for those not familiar with soil and crop problems under irrigation" but who have a desire to learn. It deals with raising crops under irrigation rather than with the application of water to growing crops, but the latter is given considerable attention.

The opening part deals with the "history, times and principles of irrigation," and is rather light and in places seems a little loose in historical statements. The body of the book is a detailed discussion of the several crops grown under irrigation and should be of great value to students young and old, in school and on the farm. At the close of the book there are some miscellaneous irrigation data, engineering and statistical. The illustrations are all either useful or interesting, most of the halftones falling in the latter class except as they stimulate interest by picturing various dams and other irrigation works which oftentimes have no specific relation to the text.

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HANDBOOK FOR HEATING AND VENTILATING ENGINEERS—By James D. Hoffman, M. Am.Soc. M. E., Professor of Mechanical Engineering and Practical Mechanics, assisted by Benedict F. Raber, Assistant Professor of Mechanical Engineering; University of Nebraska. New York and London: McGraw-Hill Publishing Co. Leather (flexible); 4x7 in.; pp. 401; 151 text figures. $3.50, net.

The first edition of this book was reviewed in "Engineering News," Jan. 19, 1911, being then commended in general and in several particulars but adversely criticised as to a few minor details. The most of these points have been cov-

ered in the revision for this second edition. The text on air washing and humidifying has been amplified and chapters on cooling have been added. An attempt has been made to bring all the pages up to date and to incorporate the maximum number of suggestions received from readers. The effect on the whole has been to emphasize practical points.

## An Authentic Compilation of Analyses of American Coals

ANALYSES OF COALS IN THE UNITED STATES, With Descriptions of Mine and Field Samples Collected between July 1, 1904, and June 30, 1910—By N. W. Lord, with Chapters by J. A. Holmes, F. M. Stanton, A. C. Fielder and Samuel Sanford. Bulletin 22 in Two Volumes. Part I—Analyses. Part II—Descriptions of Samples. Washington, D. C.: Bureau of Mines. Paper; 6x9 in.; pp. 1200.

Those who have sought comparable analyses of the various typical coals mined in this country have realized the unsatisfactory condition of the records that were available. This or that compiler has brought out what he considered typical examples but these were pitifully meager at best. Moreover any such random compilation has furnished data not really comparable except in the roughest sort of way, since the analyses were made under varied conditions, by various laboratory methods.

The most reliable and comparable figures admittedly are those secured by the U. S. Geological Survey and its successor in the survey of the deposits of the country, the U. S. Bureau of Mines. If uniform sampling conditions and laboratory practice could ever be secured it would seem to be in such bureau work. Heretofore it has been necessary to search the miscellaneous bulletins of the Bureau for the desired analyses. This labor is now eliminated by the assembly of all available analyses in one bulletin together with descriptions of the mines and samples and notes on the methods of sampling and analysis. Reports on some 5000 samples from 1500 mines and prospects are seen, thus covering all the important fields and practically all the most important districts.

There seems only one general omission—the complete absence of ash analyses beyond the mere percentages under proximate analyses of the coals. It is beyond probability that ash analyses were completed for all the samples taken, but it is improbable that none were made. The compilers would have done well to append what such data they had.

THE MAKING OF A TOWN—By Frank L. McVey, President of the University of North Dakota; author of "Modern Industrialism," "Railroad Transportation" and several other books. Chicago, Ill.: A. C. McClurg & Co. Cloth; 5x8 in.; pp. 221. $1 net.

The upbuilding of the smaller town, or perhaps one should say the smaller cities and the villages, is the theme of this book. Coöperation, planning, health, schools, morals, business, the entrance to the town, government and administration, are the principal topics treated.

In the main the book is of the inspirational order, with many practical suggestions, but brief and sketchy and in some cases inaccurate. Instances of loose or inaccurate statements are: Advice under town planning to have a park in the "center" of every town, provided with "a baseball diamond, tennis court and a ball ground"; placing of garbage removal at the head of public health activities and the complete failure to bring out the fundamental principles of public health protection; and, to name only one more, the statement that "one acre of land will absorb [broad irrigation] the sewage of 2000 persons," which is a gross exaggeration.

It is to be hoped that the author will soon have an opportunity to remove these and other unfortunate statements in a new edition, for the book has a good tone, is sound in most fundamentals and promises to be of material service to scores of towns and smaller cities just awakening to their haphazard growth, ugliness, unhealthfulness, lack of civic spirit and of public improvements.

THE HISTORY OF THE E. I. DU PONT DE NEMOURS POWDER CO. New York City: "Business America," 39 West 32d St. Cloth; 6x9 in.; pp. 224; illustrated. $1.50, net.

The fact is widely known that the Du Pont powder company is over a hundred years old, and that the original family still retains control. Beyond those simple matters comparatively little information has been widely available about one of the most interesting enterprises of this country. This account, therefore, will be more carefully preserved by all who receive it than any story of a younger and more prosaic industry.

The book gives first a short outline of the development of explosives and then the history of the Du Pont family of Nemours, France. The reasons for emigrating to America are shown, and the result, which was the establishment of the first American powder mill. The volume goes on to trace the development of the powder industry and the Du Ponts. Then a chapter is interposed on the commercial uses of powder as contrasted with military service. As one reads further he finds a description of the Repauno dynamite works near Chester, Penn., the Experimental Station near Wilmington, Del., and the Eastern Laboratory near the Repauno works. The book closes with an outline of the present commercial organization, with facts and figures of assets, liabilities, earnings, financial history, etc.

THE PRINCIPLES OF THE APPLICATION OF POWER TO ROAD TRANSPORT—By H. E. Wimperis, M. I. E. E., author of "The Internal Combustion Engine" and "A Primer of the Internal Combustion Engine." [A Series of Six Lectures Delivered at the Technical College, Finsbury.] London: Constable & Co., Ltd. Cloth; 5x8 in.; pp. xii + 130; 134 text illustrations. 4/6, net.

This book contains six lectures delivered at the Technical College, Finsbury, by the author. It will be manifest that it would be impossible, in six lectures, to give more than a cursory survey of the broad subject chosen by the author for the title of this book. Instead of the lectures being a popular exposition of the subject, such as is usually given in a lecture course, they are to a large extent technical and abound in formulas, tables, diagrams, etc.

The author's aim, as expressed in his preface, has been to formulate a working theory for the design of power-driven road vehicles based upon published tests and also tests made by the author himself with the accelerometer. Whether this working theory of the author will be found actually useful by practical designers is a point on which we must confess scepticism. The number of variables in the mechanism of a car and of the road which it travels upon appear to be far too great to admit of the reduction of design problems to any such cut-and-dried basis. For example, the book is based on English practice and English conditions. The horsepower of the cars which are cited in the table on p. 60 of the book is about half or two-thirds the power of similar cars for American service.

One is inclined to query the reliability and accuracy of some of the figures given by the author on which he bases his work. For example, he gives a table for tractive resistance in pounds per ton varying from 50 lb. on granite pavement to 140 lb. on tar macadam rough and cut up. This appears to be based on tests made with a vehicle having steel tires behind and solid rubber tires in front. It will readily be recognized that such a type of vehicle does not correspond to anything in American practice at least. In another place the author asserts that the friction of an engine is the same at all loads; that is to say that the friction is as great when carrying its maximum load as when running idle.

It is probably true that a thorough and reliable treatise upon the subject represented by the title of this book would fill a wide field of usefulness. The present volume may be of assistance to some engineers in the lack of something more complete.

SCIENTIFIC AMERICAN REFERENCE BOOK—Edition of 1914. Compiled and edited by Albert A. Hopkins (For Part I, Statistical Information), Editor of "Scientific American Cyclopedia of Formulas," "Scientific American Handbook of Travel," etc., and A. Russell Bond (For Part II, Scientific Information), Editor of "Handyman's Workshop and Laboratory." New York City: Munn & Co., Inc. Cloth; 5x8 in.; pp. v+597; 1000 illustrations. $1.50, net.

For condensed information on a wide variety of topics of scientific and popular interest this handbook is probably the best available. Much of the contents is based on census statistics, but is here given in a form more interesting to the general public than in the U. S. Census Bulletins. The chapter on the Panama Canal is prepared by the Secretary of the Isthmian Canal Commission and gives an excellent summary of the statistics of this work.

Briefly the book contains 12 to 40 pages each of statistical information on (1) Population and social statistics; (2) Farms, foods and forests; (3) Mines and quarries; (4) Manufactures; (5) Commerce (6) Mercantile marine; (7) Railroads; (8) Panama canal; (9) Telegraphs and cables; (10) Wireless telegraphy; (11) Telephone statistics of the world; (12) Post office; (13) Patents, trade-marks and copyrights; (14) Armies of the world; (15) Navies of the world; (16) Aviation; and scientific information on chemistry, astronomy and time, meteorology, machine elements and mechanical movements, geometrical constructions, and weight and measures.

# NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

DER ABBRUCH VON BETON -UND EISENBETONBAUTEN: Eine technischwirtschaftliche Studie—von Ernst Schick. Berlin: Wilhelm Ernst & Sohn. Paper; 5x8 in.; pp. 37; 7 illustrations. 1.20 Marks.

THE AMERICAN OFFICE; Its Organization, Management and Records—By J. William Schulze, Assistant Secretary, Alexander Hamilton Institute, New York; Lecturer on Office Organization and Management, New York University. New York: Key Publishing Co. Cloth; 6x9 in.; pp. 380; illustrated. $3, net.

AMERICAN RAILROAD ECONOMICS: A Text-Book for Investors and Students—By A. M. Sakolski, Staff Lecturer in New York University School of Commerce, Accounts and Finance. New York: The Macmillan Co. Cloth; 5x8 in.; pp. xii + 295. $1.25, net.

AMERICAN ROAD BUILDERS' ASSOCIATION — Proceedings of Ninth Annual Convention. New York City: The Association, 150 Nassau St. Paper; 6x9 in.; pp. 315. $2.

AUTOMATISCHE REGISTRIERWAGEN: Eine Sammlung bewährter Konstruktionen nebst eläuterndem Text—By O. Tauchnitz. München and Berlin: R. Oldenbourg. Cloth; 7x10 in.; pp. vi + 124; 118 text figures and folding plates. 8 Marks.

BERECHNUNG DER KALTEMASCHINEN Auf Grund der Entropie-Diagramme—Von Dipl.-Ing. Prof. P. Ostertag. Berlin: Julius Springer. Paper; 6x9 in.; pp. vi + 77; 30 text figures and 4 folding charts. 4 Marks.

BUREAU OF MINES, PROVINCE OF ONTARIO—22nd Annual Report, 1913, Being Vol. XXII, Part I. Toronto; Department of Lands, Forests and Mines. Paper; 7x10 in.; pp. 284; illustrated.

BUSINESS METHODS IN MUNICIPAL WORKS—An informal record of the operations of the Philadelphia (Penn.) Department of Public Works under the Administration of Mayor Blankenburg. (Room 216, City Hall). Paper; 6x9 in.; pp. 64.

CRANES AND HOISTS; Their Construction and Calculation—By Hermann Wilda. Translated from the German and Adapted to British Practice by Chas. Salter. [The Broadway Series of Engineering Handbooks, Vol. VI.] London: Scott, Greenwood & Son. New York; D. Van Nostrand Co. Cloth; 4x7 in.; pp. viii + 159; 399 text illustrations. $1.25 (3/6), net.

DETERMINATION OF TIME, LONGITUDE, LATITUDE AND AZIMUTH—By William Bowie, Inspector of Geodetic Work and Chief of the Computing Division. Fifth edition. [Special Publication No. 14.] Washington, D. C.: U. S. Coast and Geodetic Survey. Paper; 9x12 in.; pp. 177; illustrated.

DER EISENBETONBAU: Ein Leitfaden für Schule und Praxis—Von C. Kersten, Oberingenieur und Oberlehrer a. D. Teil II: Anwendungen im Hoch- und Tiefbau. Seventh edition, revised and enlarged. Berlin: Wilhelm Ernst & Sohn. Cloth; 5x8 in.; pp. xii + 262; 503 text illustrations. 4.40 Marks.

ELECTRICAL ENGINEERING; The Theory and Characteristics of Electrical Circuits and Machinery—By Clarence V. Christie, Assistant Professor of Electrical Engineering, McGill University, Montreal, Can. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xii+417; 378 text illustrations. $4, net.

EXPERIMENTAL WIRELESS STATIONS; Their Theory, Design, Construction and Operation, Including Wireless Telephony and Quenched Spark Systems—By Philip E. Edelman, author of "Inventions and Patents," "Simple Experiments in Chemistry," "How to Comply with the New Wireless Law," etc. Revised edition. Minneapolis, Minn.: The Author. Cloth; 5x8 in.; pp. 219; 80 illustrations. $1.50.

FIRST-AID INSTRUCTIONS FOR MINERS—By M. W. Glasgow, W. A. Raudenbush and C. O. Roberts. Washington, D. C.: Bureau of Mines. Paper; 6x9 in.; pp. 66; illustrated.

THE GAS WORKS DIRECTORY AND STATISTICS, 1913-14, With a List of Chairmen, Managers, Engineers and Secretaries, and Lists of Associations of Engineers and Managers. London: Hazell, Watson and Viney, Ltd. Cloth; 6x9 in.; pp. 563. 10/6, net.

A GENERAL SUMMARY OF THE MINERAL PRODUCTION OF CANADA During 1912—Ottawa: Department of Mines. Paper; 7x10 in.; pp. 46.

INGENIEUR-MATHEMATIK: Lehrbuch der höheren Mathematik für die technischen Berufé—Von Heinz Egerer, Professor für Ingenieur-Mechanik und Material-Prufung an der Technischen Hochschule Drontheim. Part I. Berlin: Julius Springer. Cloth; 6x9 in.; pp. viii + 501; 330 text figures. 12 Marks.

A LABORATORY STUDY OF THE INFLAMMABILITY OF COAL DUST—J. C. W. Frazer, E. J. Hoffman and A. Scholl, Jr. Bulletin 50. Washington, D. C.: Bureau of Mines. Paper; 6x9 in.; pp. 60; illustrated.

LEHRBUCH DER TECHNISCHEN PHYSIK—Von Dr. Hans Lorenz. Vierter Band: Technische Elastizitätslehre. München and Berlin: R. Oldenbourg. Paper; 6x9 in.; pp. xxiv + 692; 229 text illustrations. 19 Marks.

MINE SURVEYING—By Edward B. Durham, Associate Professor of Mining, University of California. New York and London. McGraw-Hill Book Co., Inc. Pocketbible leather; 5x8 in.; pp. vii + 391; 211 text illustrations. $3.50 net.

MITTEILUNGEN AUS DEM KONIGLICHEN MATERIAL-PRUFUNGSMAMT zu Berlin-Lichterfelde West. Sonderhefte, Heft, 1913. Berlin: Julius Springer. Paper; 8x11 in.; pp. 165 + 220; illustrated.

MORTALITY STATISTICS, 1910 — Eleventh Annual Report, Prepared under the Supervision of Cressy L. Wilbur, M. D., Chief Statistician for Vital Statistics. Washington, D. C.: Bureau of the Census. Cloth; 9x12 in.; pp. 631.

THE NEWBURGH SURVEY—Reports of Limited Investigations of Social Conditions in Newburgh, N. Y., by the Department of Surveys and Exhibits, Russell Sage Foundation, 128 East 22nd St., New York City. Paper; 6x9 in.; pp. 104; illustrated. 15c.

Among the fields covered are public health, by Franz Schneider, Jr., and municipal administration, by D. O. Decker. The high endemic typhoid, Mr. Schneider believes, reflects on the untreated surface water-supply. Mr. Decker suggests that the engineering work of the city be put in charge of a paid (full-time?) city engineer, that water meters be installed and that a plan for road improvement be formulated.

NEW YORK STATE COMMISSION OF HIGHWAYS—Report for 1912. Albany, N. Y. Cloth; 6x9 in.; pp. 694; illustrated.

THE OFFICIAL GOOD ROADS YEAR BOOK OF THE UNITED STATES, 1912—Washington, D. C.: American Association for Highway Improvement, Colorado Bldg. Cloth; 6x9 in.; pp. viii + 406.

PYROMETER TESTING AND HEAT MEASUREMENTS—Washington, D. C.: Bureau of Standards. Circular No. 7. Paper; 7x10 in.; pp. 19.

RAILWAY PROBLEMS—Edited, with an Introduction, by William Z. Ripley, Ropes Professor of Economics, Harvard University. Revised edition. Boston, New York and London: Ginn & Co. Cloth; 6x9 in.; pp. xxxiv + 830; illustrated. $2.50.

LA RESISTENZA DELLE ARTIGLIERIE—Nuovi studi degli ingegneri Leone Goupaye a Pietro Malaval dell' Artiglieria navale francese. Traduzione e prefazione di Ettore Bravette capitano di vascello R. N. Turin, Italy: Carlo Pasta, Piazza Castello, 22. Paper; 7x10 in.; pp. xxxii + 262; 43 text figures, and several folding tables. 8 Lire.

STATISTICS OF RAILWAYS IN THE UNITED STATES—24th Annual Report for Year Ended June 30, 1911. Prepared by the Division of Statistics. Washington, D. C.: Interstate Commerce Commission. Cloth; 9x12 in.; pp. 763.

STEAM; ITS GENERATION AND USE—The Babcock & Wilcox Co., 85 Liberty St., New York. 35th edition. Cloth; 7x10 in.; pp. 335; 41 text figures; numerous plates.

In the earlier days of the water-tube boiler, this book, though in one sense a trade catalog, was well known and widely appreciated by all who liked a simple exposition of the theory and art of making "safety boilers." The present edition shows great changes from the editions of several years ago in size and contents. There are, of course, the familiar arguments for this company's practice, but also much useful up-to-date matter on heat, feed water, steam, flue gases, coals, oil fuel, draft, boiler testing, etc.

SUMMARY OF COMMONWEALTH STATISTICS OF TRANSPORT AND COMMUNICATION for the Years 1902 to 1912—Melbourne, Australia: Commonwealth Bureau of Census and Statistics. Paper; 8x13 in.; pp. 41.

TABLES FOR STEEL DETAILING AND DESIGNING—By J. A. Auringer, New York: W. T. Hunt, Jr., 150 Nassau St. Leather; 5x8 in. $7, net.

THE THEORY AND PRACTICE OF HEATING AND VENTILATION—By Arthur H. Barker, Managing Director of J. F. Phillips & Son, Ltd.; author of "Graphical Calculus," "Graphic Methods of Engine Design," "Management of Small Engineering Workships," etc. London: Sidney Carton & Co. Cloth; 7x10 in.; pp. xvi + 640; 142 text figures and 33 tables. 25/-, net.

TRANSIT COMMISSIONER, CITY OF PHILADELPHIA—Report of A. Merritt Taylor, July, 1913. Cloth; 8x11 in. Vol. I, pp. 267. Vol. II, 69 folding maps and plans.

UNDERGROUND WATERS FOR COMMERCIAL PURPOSES—By Frank L. Rector, M. D., Bacteriologist, Great Bear Spring Co., New York. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. v + 97; illustrated. $1, (4/6), net.

Chiefly of value to those engaged in the bottled water trade who are not familiar and do not care to familiarize themselves with the broader phases of potable water-supplies. The various sources of water-supply and methods of water examination are outlined in familiar terms and there are a few pages on mineral waters. There are also a few tables and a short bibliography. The book seems to be satisfactory within its limits but it is so limited in scope and contains so little not readily available elsewhere as to raise a question regarding its justification.

USES OF COMMERCIAL WOODS OF THE UNITED STATES; Beech, Birches and Maples—By Hu Maxwell, Expert. Bulletin 12, Washington, D. C.: U. S. Department of Agriculture. Paper; 6x9 in.; pp. 56.

WIRELESS TELEGRAPHY—By C. L. Fortescue, Professor of Physics, Royal Naval College, Greenwich, Cambridge, England: University Press. New York: G. P. Putnam's Sons. Cloth; 5x7 in.; pp. vi + 143; 20 illustrations. 40c., net.